THE GLASS INDUSTRY

VOLUME 33, NUMBER 12, DECEMBER, 1952

INTERNAL SURFACE DAMAGE TO BOTTLES

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Abstract

Washing machines that introduce metal parts into the interior of bottles for the purpose of brushing them out, usual for re-use, are apparently difficult to maintain in perfect condition, and if the metal rubs on the glass while the latter is very clean, due to the presence of modern washing alkalies or detergents, abrasions are made on the interior surface of the bottle. Even when very faint and inconspicuous, these greatly reduce the strength of the bottles to withstand impacts at the point of damage, and the bottles are frequently rendered unsafe for further use.

Historical

Some 12 or 15 years ago, a complaint was received by a bottle manufacturing company that out in Indiana its bottles would not go through the filling line of a soft-drink bottler. They were breaking at an alarming rate, usually "exploding." What was the matter? Were the bottles not annealed? Or made of inferior glass? The superintendent of the manufacturer went out to see, and came back reporting that the trouble was genuine, for the bottles were going off like firecrackers in the man's plant.

Since the reality of the trouble was established but its cause entirely obscure at this point, J. M. McCormick of the Preston Laboratories was sent out to see what was going on. He came back with a large sample of the offending bottles and a report that it sounded like live ammunition in the bottling plant.

Casual inspection showed no obvious defects in the bottles. They were properly annealed, adequately homogeneous, of a good uniform distribution, and on the face of things strength ought to be very good indeed. We had previously given a pressure test to a sizable sample of the manufacturer's output before he shipped it to Indiana and this confirmed that the bottles did in fact have high strength. Dr. L. G. Ghering now proceeded to test the bottles brought back from Indiana by McCormick. He found that the hydrostatic pressure strength was slightly lower than in bottles fresh from the manufacturer, but not much so. This confirmed the manufacturer's own findings. Statistically, it hardly looked significant, still less important.

But here the techniques of "fracture analysis" disclosed something that mere testing did not. Ghering observed that the origin of the fracture was not normal in appearance, though it was in a normal position on the sidewall and the general fracture pattern was standard. The normal semi-elliptical mirror area was not on the outside surface of the bottle, but a rather different looking origin was on the inner surface, something we had never seen before.

Theodore C. Baker, who was at the Preston Laboratories in those days, immediately concluded that there must be something radically wrong with the inside surface, and that if he cleaned it and dried it and looked carefully enough in a good light, he might be able to see it. He succeeded. What he found were faint but unmistakable abrasions in the form of horizontal or spiral "chatter-sleeks," readily visible in a good light when the bottles were thoroughly dried, but quite invisible when they were wet. He showed further that the origin of the fracture was always exactly at one of these sleeks, never between them.

Dr. Robert G. Hunter, who also in those days was attached to these Laboratories, immediately announced that if that were the case, the bottles, though they might be strong as regards internal pressure, would be woefully weak as regards resistance to impact. He laid a pristine bottle on its side, and showed that a one-inch diameter steel ball would bounce harmlessly off the bottle when dropped from a height of two or three feet; but on taking a similar bottle with the faint chatter-sleek on it, the bottle broke if the ball fell only three or four inches, provided it struck directly over a sleek.

Now, Hunter himself had just previously received a complaint that at Cleveland, Ohio, the experience of a different bottler, using bottles of a different manufacturer, was very similar to the Indiana story. He had gone to Cleveland and found that it was so, and had reported that handling of the bottles was exceptionally rough, and that the breakage was from impact.

Examination of much larger numbers of bottles now disclosed that after bottles had been internally abraded, it happened, not seldom, that impacts on their sidewalls produced *partial* failure; that is, the formation of short

splits, perhaps half an inch to an inch long, on the inner face of the bottle. These splits were usually vertical because the chatter-sleeks were horizontal and the individual chatter marks therefore vertical; and it was one of these individual marks that became elongated into a crack.

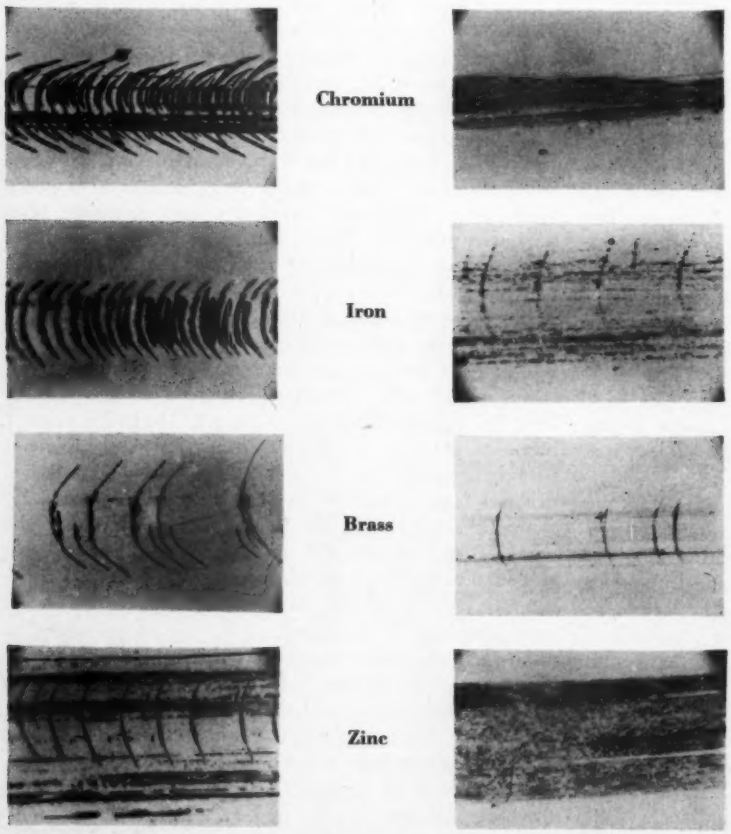
The next problem was to find how the chatter-sleeks got inside the bottle. They were not there when the bottles left the manufacturer's plant. They were there, sometimes, before the bottles left the bottler's plant for the first time. It was soon discovered that they were introduced by worn brushes and the spindles of the washing machine in the bottler's plant.

In quick succession, now, complaints of the same trouble began to come in from other parts of the country, and in all cases it was found that the origin of the trouble was the same.

Why was the trouble suddenly so much worse, apparently, than it had been? There were several factors. First, new styles of bottles were coming into use and these did not always fit the pockets of the washing machines. More powerful detergents were said to be coming into use, so the glass was getting cleaner and therefore more easily scratched. There was some wondering at the time whether there had been some subtle change in glass composition, nation-wide in scope, that made the glass more vulnerable, but this seemed improbable. There were also suspicions expressed that fusible frit labels, which were a novelty at that time, were somehow responsible for increased vulnerability, but the only effect that could have come from that development was a change in the shape of the bottle, from one having blown-in decoration to one having applied decoration. However, the Coca-Cola Company did not make that switch, and yet was encountering some trouble.

We therefore took the matter up with the trade association of the soft drink industry, the American Bottlers of Carbonated Beverages, of which John Riley was Manager and Dr. John Sharf, Technical Advisor. Dr. Sharf gave us a courteous reception, made enough tests of his own to satisfy himself that we were right, and endorsed our attitude. Meetings were then held with representatives of the franchise holders and several of them sent representatives to Butler to study the subject in detail with Dr. Ghering.

In spite of this, for a time things took a turn for the worse. To the bottler, any appreciable failure of his bottles means a financial loss. Not only does he lose his bottles, but he loses the contents, and, what is worse still, the time lost in cleaning up the debris and stopping his filling line while he does it is costly. Further, it represents a hazard to his employees. They may get cut or even seriously injured. But the turn for the worse comes about when the damaged bottles, loaded with charged liquid, get out into the hands of the general public and there, spontaneously, or upon receiving a modest tap on the side, "explode" and throw fragments of glass around. Some serious injuries have resulted from such a happening.



Figures 1-4. Typical chatter-tracks formed by various metals. Left, etched; right, not etched.

Fig. 5. Abrasions inside body of bottle.

Fig. 6. Abrasions inside body. Above, before etching; below, after etching. Same magnification for both views.

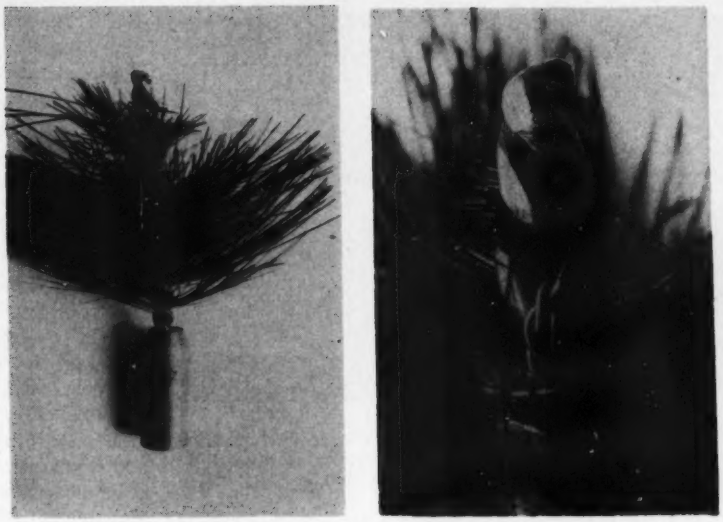


Fig. 7. Exposed tip of body-wire of a worn brush. Left, natural size; right, under magnification.

Meanwhile, over in England, J. B. Murgatroyd at just about the same time discovered the same phenomenon. His experiences remained unknown to us for ten years. Every now and then he would receive a complaint about bottles not standing up in service, and he would say, "Throw out your old-fashioned brush-type washer, and you won't have that trouble." And the reply was invariably, "How do you know we have a brush-type washer?"

In this country efforts continued for a long time to straighten out the difficulty. The dangers of internally scratched bottles were described and demonstrated at the meeting, at Old Point Comfort, of the Glass Division of the American Ceramic Society in 1938.

J. C. Turnbull[1] made a number of experiments to see what metals would scratch clean glass, and, with L. G. Ghering, reported his findings in a paper to the American Ceramic Society in 1940. In several other papers, and at various times, the matter has been mentioned in the scientific press.

A committee, representing glass manufacturers and the Preston Laboratories, collaborated with a number of bottlers in an effort to reduce or eliminate the hazard. The members of that committee had considerable experience of their own, and on the basis of this experience and on the basis of spot-surveys of the condition of reused bottles in many cities, and on the results of a series of tests in a bottling plant in Western Pennsylvania, the committee has inclined to the view that it is impracticable to maintain adequately a brush-type washer that uses bare metal spindles, lift plugs and rinse tubes. Tests were also made of the effect of additions to detergents that were supposed to lessen the vulnerability of glass to abrasion, or to reduce the abrasions themselves to a less dangerous state, and found that the advantages were negligible. It was concluded that bottles intended to hold pressure must, in the public interest, be protected from internal scratchings, and that such protection could not be achieved in the present state of the art so long as brush-type washers were used, *if the brushes had metal parts*, with any reasonable amount of effort in maintenance.

The most important categories of bottles that must carry internal "hydrostatic" pressure, and have been found scratched in some numbers, are bottles for carbon-

Fig. 8. Horizontal abrasions inside the neck of a bottle.

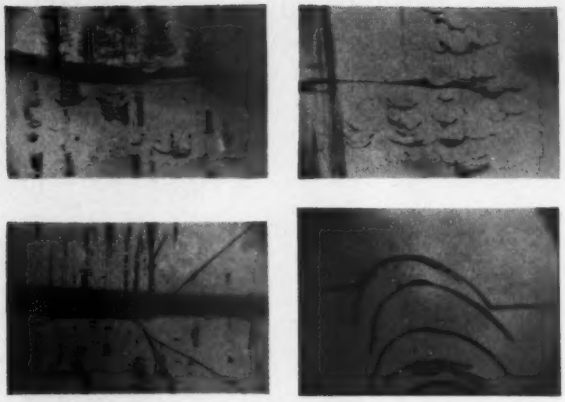


Fig. 9. Four examples of chatter-track abrasions extended to form a crack. Various magnifications. Note in the bottom right view that it is a single crescent that is extended to form the crack.

ated beverages ("soft drinks") and beer bottles.

Since many years of investigation have gone into this subject, and seemingly definite conclusions have now been reached, it seems advisable to report the present state of our knowledge and of the art. Internal scratching is apparently still occurring, and though it is better understood than it was ten years ago, it is still not a negligible matter.

The Physics of the Problem

The laws of friction between solid bodies, commonly attributed to Coulomb, relate to bodies which neither fit together at all well nor are free from surface contamination. This contamination may consist of adsorbed moisture, or traces of oil or grease or "dirt," and all surfaces tend to accumulate such films. When the films are removed, the surface is said to be "chemically clean," but chemical cleanness is also regarded as achieved when the only contaminant is water. When chemical cleanness, or a close approximation to it, is achieved, the properties of the surfaces become very different, and the surfaces in contact, even if they do not "fit," are likely to "seize." This was demonstrated for glass surfaces in a good deal of detail by Hardy (1919).[2]

Glass on glass is not the only combination that seizes. Glass and metals and glass and polishing oxides seem to seize similarly, and while chemical cleanness emphasizes the seizing, it is not an absolute necessity. The surfaces seize at minute points, then let go and seize again a minute distance away so that there is a skipping or jumping action. Friction under these circumstances is essentially a dynamic action and cannot be understood in static terms. The normal manifestation of such a motion is the "chatter-sleek" (Preston, 1921) or, seeing that the term sleek is a technical one confined to almost ultra-microscopic tracks in the polishing industry, we may perhaps call them "chatter-tracks." They occur on an enormous scale in geological phenomena (Chamberlin, 1885)[3], while Turnbull and Ghering (1940) have experimented with them on glass, using a variety of metals for contacting points (Figs. 1-4). Here the tracks are of an intermediate size, approximating the size that most concerns us in the present problem. The present writer had made such tracks with steel balls much earlier (Preston, 1921)[4] but without any particular reference to the cleanness of the surface or the variety of metals that could produce the result.

The chatter-track, therefore, the trail or evidence of the passage of a dynamic, bouncing abradant across the surface, is a common and important phenomenon upon polished glass surfaces. It is evident that it may be produced on any scale from microscopic, possibly ultramicroscopic, to very large; that it may be produced in a variety of industrial operations; and that chemical cleanness is not essential. The appearance of chatter-tracks, having been discussed in earlier papers, need not concern us here. They consist of a series of flaws, outcropping on the surface in crescentic form *behind* the chattering tool, so that their concave sides face forward, i.e., towards a latter crescent. Their sub-surface topography, or form in three dimensions, is discussed in the author's paper of 1921. What we are here concerned with is the effect of such abrasions upon the strength of glass, a matter not discussed in that earlier paper.

It should be noted that in the making of a chatter-track, no material is actually removed. Further, there is no "scratch" of a continuous nature. The individual crescentic cracks that cross the track, and define the track, do not communicate with one another. Each is an entity of its own made in its entirety perhaps before any part of the next crescent is formed. Any contact between one and another is fortuitous and represents a complication, so to speak.

Scratches and cracks and abrasions of other kinds can be made upon glass surfaces. Chatter-tracks are typically the trails of *blunt* tools, sometimes of comparatively soft tools, that have seized to the surface momentarily and gone chattering across it. The process may set up a high-frequency vibration in the glass or tool, or both, so that presumably every chatter-sleek is made to the accompaniment of an unearthly shriek, though the frequency may sometimes be ultrasonic.

When we refer to the "internal scratching" of bottles, or to "internal abrasions," we normally mean the presence of chatter-tracks upon the inside surface of the bottle (Figs. 5 and 6). Such tracks can presumably be made by a variety of operations, but the principal one seems to be the operation of washing by machines that introduce rotating metal spindles, ferrules, shafts, or brush-wires into the inside of the bottle. These are not supposed (in most cases) to touch the glass at all. The wires of the brushes that hold the bristles in place, for instance, are supposed to be held out of contact with the glass by means of the bristles themselves. But the bristles wear off, and then it sometimes becomes possible for the metal to touch the glass. Sometimes worn spots can be observed on the wire (Fig. 7) indicating that it has been rubbing on something or other, and presumably this something is sometimes the glass. There is not much surmise about this for the position of the abrasions on the glass agrees with the defects in the tools. Those washing machines that do not use metal parts to enter the bottle do not, within our experience (which is considerable), cause chatter-tracks on the inside. Those that do use such metal parts seem frequently, and indeed almost invariably, to produce a proportion of bottles with damaged interiors. Since the bottles are used many times over, the proportion of damaged bottles may become quite high

in the long run. We have found instances where the damaged proportion exceeded 90%.

The damage may be in the barrel of the bottle or in the neck. As a rule, the chatter-tracks in the wide part of the bottle are due to worn brushes exposing the twisted wire that holds the bristle. Such tracks are usually narrow ones, but often long ones, running peripherally around the bottle. Tracks in the neck are usually made with a heavier part of the tool. They are often shorter, but wider, and their detail is sometimes easily seen with the naked eye (Fig. 8).

The next step in destroying the bottle consists in tapping the *outside* of the bottle with some hard object. Another bottle will frequently suffice. This may, and often does, cause one of the crescentic cracks to extend. Typically it extends at right angles to the track because that is the general direction of the initial crescent (Fig. 9). This extension may be catastrophic; that is, it may break the bottle apart then and there, the extension being great (Fig. 10). However, it may be more insidious and subtle, extending the crescent only a modest distance (Figs. 11 and 12).* We have frequently found such extensions half an inch or so in length, and not cutting completely through the thickness of the bottle.

The bottle is now definitely a cracked bottle and is vulnerable to forces that previously it might withstand. Internal pressures of reasonable amount will not normally cause a crescentic crack to open further, but if the crescent has been extended to a sizable crack, a very modest internal pressure, from carbonated beverage perhaps, may cause it to do so. The extension is sometimes slow, and becomes catastrophic only when the total length of the crack has reached a critical value. Thermal shocks can also extend a pre-existing crack, and mechanical shocks (i.e., further impacts or tapping) readily do so. Thus, the destruction of the bottle may be accomplished in three stages: (a) the formation of a chatter-track in the washing process, (b) the extension of a crescent into a much longer crack by external impacts which otherwise would have had no effect and (c) any further disturbance or force exercised by internal pressure, further impact, and so on.

Economic and Other Aspects of the Problem

Bottles that are internally scratched in the barrel, or wide parts, are not likely to last long. The probability of their receiving external impacts at this level is too great. Breakage may occur on a grand scale in the filling plant, and this necessarily focuses attention on the fact that there is some serious trouble to be eliminated. It represents a serious, and very obvious, economic loss and is likely to result in a complaint to the bottle manufacturer, who thereby becomes aware of it, too. Bottles that are scratched in the neck are less likely to be impacted at

* Figures 10, 11 and 12 represent cracks extended on empty bottles.

Fig. 10. Mild blow over abrasions inside the barrel of an empty bottle.

Fig. 11. Mild blow over abrasions inside neck of an empty bottle forming a vertical crack about an inch long. The crack shows as a white mirror-like crescent.

Fig. 12. Mild blow over abrasions inside neck of an empty bottle. Resulting crack does not extend through glass. In this lighting, the crack shows as a dark mark.

the critical point and may survive for a long time. There is no doubt some shortening of their useful life, and hence in all probability an economic loss, but it is not so obvious.

However, there is another aspect that concerns us. If the bottle is used to contain a liquid under pressure, it may, if it breaks, throw fragments with some violence to quite a distance. This may result in injuries to personnel in the bottling plant, or to the general public, and sometimes these may be serious injuries. Cracked bottles here present a hazard that is not definable in strictly economic terms. The transition from a chatter-tracked bottle to a partially-split one is easy, but not always easily detected, nor does it necessarily occur when an expert examiner is on hand to detect it. Thus, a chatter-marked bottle should not be used for a pressure vessel unless and until some method is found for rendering chatter-tracks innocuous and incapable of being extended into major cracks.

A variety of suggestions has been made by many interested parties as to how this might be done. All suggestions that have come to us have been investigated conscientiously, but no practical method has yet been uncovered. This paper may serve to call the attention of inventors and investigators to the desirability of such a discovery. Meanwhile, such injured bottles must be regarded as unsafe.

REFERENCES

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[3]Chamberlin, T. C. (1885-86) "The rock-scorings of the great ice invasions," *U. S. Geological Survey, Seventh Annual Report*, pp. 155-248.
[4]Preston, F. W. (1921) "The structure of abraded glass surfaces," *Trans. Opt. Soc. London, 23*, (3) pp. 141-64.

SOCIETY OF GLASS TECHNOLOGY ANNOUNCES MEETINGS FOR 1952-1953 SESSION

The program for the 1952-1953 session of the Society of Glass Technology has been announced and include the following subjects: *October 28 and 29, 1952*, "The Sintering of Pure Oxides" by J. White and J. H. Cannon; "Time and Motion Study in the Glass Industry" by E. R. Weston; "The Determination of Small Amounts of Fluorine in Glass" by R. S. Allison. *November 25 and 26, 1952*, "The Rates of Reaction of Silica with Certain Oxides: Parts I to V" by Abd El Moneim Abou El Azm and Professor H. Moore. *January 27 and 28, 1953*, "Stress Release in Fused Silica" by R. W. Douglas and J. O. Isard; "Compressed Glass-to-Metal Seals" by H. Adam. *February 24 and 25, 1953*, "Suitable Glass Compositions for Different Methods of Mechanical Manipulation," a symposium. *March 24 and 25, 1953*, "Devitrification Characteristics of Some Simple Glasses" by A. J. Milne; "Infrared Reflection Spectra of Glass" by P. E. Jellyman; "Khasia Sillimanate" by C. F. Griffith. *April 28 and 29, 1953*, Annual Dinner, Dance and General Meeting; "The Color of Nickel in Glasses of Varying Composition" by H. F. Winklemann and Professor H. Moore *or* "The Viscosity-Temperature Characteristics of a Soda-Linme-Silica Glass when Soda, Lime and Silica are Partially Replaced by Other Oxides" by A. G. F. Dingwall and Professor H. Moore. *May 14 and 15, 1953*, Joint Meeting with the British Ceramic Society and the Institute of Vitreous Enamellers; "The Work of the International Flame Radiation Committee" by M. W. Thring; "The Industrial Application of Statistics in Industry" by B. P. Dudding; "Mechancial Handling in the Glass and Ceramic Industries" by J. Gardom.

PACIFIC COAST JOINT GLASS MEETING FEATURES ELECTRIC GLASS MELTING

The Glass Club of Southern California joined with the local section of the American Ceramic Society in their regularly scheduled monthly meeting and technical session.

The guest of the evening was Larry Penberthy, of Penberthy Scientific Instrument Company, who informally discussed certain aspects of the electric melting of glass. After discussing early experiences with small scale melts, Mr. Penberthy developed the subject to include modern practices, with particular reference to the comments that appeared in the August 1952 issue of THE GLASS INDUSTRY.

The discussion opened up new vistas for the future and pointed toward rapid growth in the application of electric melting towards making colored and special glasses, as well as towards "boosters" for modern flint tanks.

Following Mr. Penberthy's discussion, H. H. Douglas, senior power engineer of the Southern California Edison Company, commented on electric melting insofar as the source for power in Southern California is concerned. The members of the Glass Club left the meeting with a renewed interest in melting glass electrically.

Brief comments were then made by V. C. Swicker concerning a recent visit to the Westvaco soda ash plant and mine at Green River, Wyoming, as well as to the elementary phosphorus plants in Pocatell, Idaho. The soda ash plant will be in operation about the first of 1953 and the estimated production is 300,000 tons per year.

The bi-monthly meeting of the Glass Club featured John W. Rogers and R. L. Blessing of Laclede-Christy Company, who discussed the manufacture of refractories and the use to which refractories are put throughout the glass industry. Mr. Blessing developed this subject on the basis of the raw materials involved and supported his remarks with color slides. Mr. Rogers' remarks were primarily based on the manufacturing process itself with particular reference to the #400 block. Numerous color slides were shown of installations in glass tanks. Of particular interest was the description of the test furnace that is used to evaluate the resistance of refractories to corrosion by molten glass.

PACIFIC COAST BORAX MAKES APPOINTMENT

Pacific Coast Borax Company, Division of Borax Consolidated, Limited, has announced the appointment of J. Fred Corkill as Vice President and Eastern Manager.

Mr. Corkill, a graduate of the University of Southern California and Loyola University Law School, has been with the company since 1935. His headquarters for the present time will continue to be in New York City.

• The opening of the Union, New Jersey, plant of the Airco Equipment Manufacturing Division of Air Reduction Company, Inc., has been announced by Scott D. Baumer, President of the Division.

GCMI HOLDS LARGEST FALL MEETING AT HOT SPRINGS

The Glass Container Manufacturers Institute went to The Homestead in Hot Springs, Va., for its Fall Semi-Annual Meeting held November 10, 11 and 12. It was the largest Fall meeting to be held by the GCMI.

Howard C. Herger, President of the Pierce Glass Company and President of the Institute, called the meeting to order promptly at 10 a.m., Monday, November 10. In his report to the assembled members, Mr. Herger comprehensively, yet succinctly, covered the many phases of the glass container industry's activities, its problems and its desired objectives in relation to competition from other container materials and the broad economic picture.

Mr. Herger's opening remarks dealt with the industry's volume and capacity. He stated that, although shipments of glass containers were off for the first half of this year, a pick-up in business during the summer months and a continuation of a satisfactory rate of shipment through September indicates total shipments for 1952 between 113 and 114 million gross, or only a negligible percentage figure under the preceding year. It was pointed out, however, that the above estimated total for the current year contemplated a slightly better volume during the last quarter than was enjoyed in 1951.

Turning to the industry's ability to produce, Mr. Herger stated that present capacity stands at 146 million gross annually. Using the volume for 1952, it was pointed out that the industry's rate of operation is only about 78 per cent of capacity. In this connection, Mr. Herger said, "notwithstanding the substantial growth in industry demand through the past ten years, ability to produce has gone ahead at a greater rate. While a few new furnaces have been added, the great part of the increase in capacity comes from technological improvements, i.e., greater tank pull, additional machines operated back to back, more dual cavity operations, etc."

Summarizing his thoughts on the matter of shipments in relation to capacity, Mr. Herger stated that there was no doubt in his mind that technological improvements would continue and will in turn exert greater pressure on the industry for increased volume.

As to the profit picture for 1952, it is felt that while volume this year will be very close to that of last year, profits will not be nearly so good. The successful efforts of the Industry Advisory Committee in its dealings with OPS in obtaining the relief granted by Order SR 99 GCPR last April, resulting in a 4 per cent increase being put into effect for most lines, was considered most fortunate. However, it was pointed out that the industry has had two complete rounds of wage increases and since part of the increase applicable to "miscellaneous" employees was subject to wage board approval and did not become generally effective until after July 1951, the cost increases granted by OPS in April did not reflect the full extent of the May 1951 wage agreements.

Assuming that the part of the last wage adjustment yet to be approved by the Wage Stabilization Board is approved, it is estimated that these increases will cost the industry annually between 15 and 16 million dollars. This added cost will represent a sizable percentage of net sales.

Freight rates, both inbound and outbound, are another heavy expense item. Since July 1951 there have been two general freight rate increases applying to both inbound and outbound freight. These were 5 per cent in August 1951 and 6 per cent in May of this year on rates in effect in 1951.

Mr. and Mrs. J. C. Feagley receiving silver service presented by the Institute in recognition of Mr. Feagley's contribution to the glass container industry as former President of the GCMI.

In connection with these costs, however, a ray of light is seen in that the industry is generally on a delivered price basis and OPS Regulation SR 122, issued during October, will no doubt be of some help since it will permit passing on the increase pertaining to outbound shipments.

Briefly reviewing the position of the closure division of the industry, Mr. Herger stated that volume this year had not kept pace with glass container shipments. Both molded and metal closure sales were off more than 20 per cent as compared to 1951. The closure division of the industry did not participate in the small relief accorded the glass container industry and it was reported that the Closure Advisory Committee has petitioned OPS for relief.

In commenting on future prospects and the need for planning, Mr. Herger pointed out "that it is generally believed that the nation's per capita income after taxes will hit a new high this year. Unemployment is at a record low, about 2 per cent of the civilian labor force, but that this prosperity is precarious and must be put on a firmer foundation, assuring an expanding economy based on private initiative as opposed to the props of public money.

While disposable income is expected to reach an all-time high this year, it is also believed that there will be a gradual decline of about 15 per cent by 1955. This assumes no radical change in personal income taxes. Since glass container demand has always followed closely the trend of disposable income, such a decline in general business would place a real strain on the glass container industry's operations.

Left to right: Mrs. J. M. Foster, Howard C. Herger, Mr. and Mrs. Philip O'C. White, J. M. Foster, and Mrs. Herger.

In contemplating the effects of a minor recession on the glass container industry, Mr. Herger noted that the industry's break-even point is considerably higher than prior to the last war due to the absorption of costs, mainly through increased volume rather than increased selling prices. Contributing further to the problem would be the fact that a much higher percentage of the industry's costs is fixed.

With regard to planning for the future, competition from competitive packaging materials is recognized and it is felt that this competition, already keen, can be expected to intensify under conditions of reduced business activity. In considering this phase of the industry's problems, Mr. Herger stated that the industry must do a real selling job in order to hold its position with competitive containers.

In elaborating on his plea for an aggressive selling job by the industry, Mr. Herger emphasized that he was not advocating a broad industry promotional campaign, but more intensive effort on the part of individual companies on new product research, packaging engineering, sales promotion and advertising. Mr. Herger further said, "It is true that two or three of the leading glass container and closure companies are doing a real job in the selling field, but the majority of the companies, including my own, are not."

As is customary, Mr. Herger, as Chairman of the Board of Trustees, reported current Institute activities to the assembled members. Among his topics was the project with the Dole Engineering Company involving the development of the Martin Aseptic Canning Method for glass packed products. Up to the middle of the year, due to lack of personnel and other circumstances, little progress had been made. However, Board approval of the employment of a full-time engineer has set the wheels in motion and definite progress is being made, Mr. Herger said.

Through an arrangement with the Food Machinery and Chemical Corporation, the Glass Container Manufacturers Institute is carrying on additional development work on an aseptic canning process for glass packed products.

Mr. Herger remarked on the advertising campaign over the signature of GCMI in THE GLASS PACKER. This campaign started with the August issue, having been recommended by the Committee on Market Research and Promotion and approved by the Board of Trustees earlier in the year.

The public relations program with the dairy industry was next commented on by Mr. Herger. Last month the first copy of the Institute's dairy house organ, *The Glass Milk Bottle*, was sent out. This is only one phase of the public relations program with the dairy industry, which is being sponsored partly by the glass container industry at large and partly by those companies who manufacture milk bottles.

In concluding, Mr. Herger said, "I must say that during my short time as President of your organization, I have been impressed with the businesslike manner in which the industry committees function and the fine work being carried on by our General Counsel, Fred Fuller, and V. L. Hall, General Manager, and his staff. The reports from the various staff members will, I am sure, thoroughly corroborate this view."

The next speaker of the first day's session was Dr. J. H. Toulouse of Owens-Illinois Glass Company, who gave a most interesting talk on Customer Acceptance Sampling Plans.

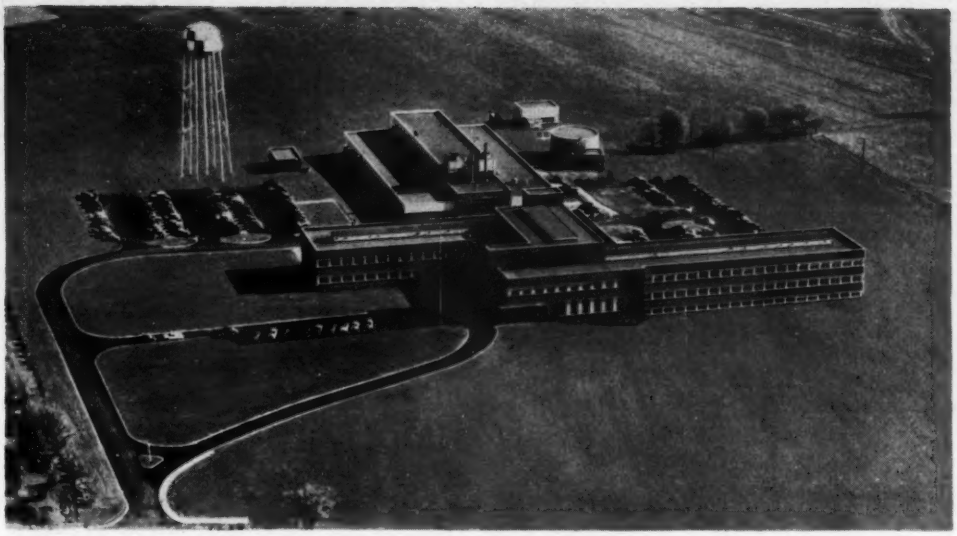
Following Dr. Toulouse was Bert W. Hendrickson of the Institute's legal advisory counsel, who discussed product liability. Dr. J. G. Turk spoke on behalf of the Committee on Package Design and Specifications and outlined the work being carried on at Preston Laboratories in Butler, Pa.

The next speaker, Fred W. Fraley, although appearing on the program as Assistant Administrator, NPA, in charge of the Chemical, Rubber and Forest Products Bureau, was well known to the GCMI membership, having an attendance record at glass container meetings dating back to 1932. Mr. Fraley is Vice President of the Diamond Alkali Company. His remarks were confined to a general description of his particular branch of NPA and comments on the possible future of the National Production Authority.

Mr. Fraley, after paying tribute to the capabilities of men he has worked with in Washington—namely, Horace McCoy, Henry Fowler, Manly Fleischmann, R. A. McDonald and Charles Lewis—stated that Mr. Lewis will become Director of the Container and Package Division in December.

John C. Clay, who is Assistant to the President of National Starch Products Company and is now serving as division director of Containers and Packaging, discussed in some detail limitation orders on various materials, including selenium and cobalt.

(*Continued on page* 676)



INTEGRATED RESEARCH AT ARMSTRONG'S NEW CENTER

Climaxing a $60,000,000 program of post-war plant modernization and general expansion, the Armstrong Cork Company has just completed extensive new laboratories which substantially extend the facilities available for research and development work in the numerous fields —including glass—in which this company is active.

Here, in the Armstrong Research and Development Center, are largely concentrated the research and development work for the company's eighteen domestic plants—including its glass plants at Millville, N. J., and Dunkirk, Indiana—for its operations abroad, and for the 350 diversified products which bear the Armstrong trademark.

Since 1938, when Armstrong acquired the Whitall-Tatum Company and the Hart Glass Manufacturing Company, its product list has included glass containers for the food, beverage, chemical and pharmaceutical trades, graduates' and other druggists' sundries, and glass insulators for the electrical industry.

Other major products of the company are bottle closures of all kinds; linoleum and other resilient floorings and wall coverings; insulations, acoustical materials and other building products; and industrial adhesives, gaskets and numerous industrial specialties of cork, rubber and other compositions.

The company's great diversity of products and activities is clearly reflected in the nature and scope of the new Research and Development Center. It is this diversity which makes it economically feasible for the company to maintain research personnel and equipment which could hardly be justified if they applied to only one field or one group of products. As a result, the research power which can be brought to bear by Armstrong in the glass field, or any other field in which the company is interested, is multiplied many times.

The Center, which was under construction for more than two years, is located on a 40-acre tract fronting on U. S. Route 30 (The Lincoln Highway) several miles west of Lancaster, Pa., and several miles from the company's general offices and huge floor plant. A semi-rural site was chosen for the Center primarily because of its remoteness from the noise, vibration, smoke and fumes commonly found in industrial areas. The 40-acre tract was acquired in order to provide ample room for expansion.

The Center consists of a main Research Building paralleling the highway; a Pilot Plant building to the rear; and several smaller specialized structures grouped near the Pilot Plant building. Total floor space is approximately 162,000 square feet.

The Main Research Building, which is composed of a central core and two wings, is two and three stories high, has an over-all length of 450 feet; the central core is 160 feet deep and the wings 60 feet deep. The building is located well back from the highway on a slight rise in the land, giving it a commanding position that lends itself well to tasteful landscaping. It is of steel frame construction, faced with red brick, and conforms to the dominant architectural style of the community. Strikingly handsome and "non-industrial" in appearance, the place is occasionally mistaken for a school, hospital or other institution by passersby who overlook the chaste sign at the highway entrance.

The central core of the main Research Building houses the lobby, the administration and staff offices, a meeting room and cafeteria, the technical library and other services. The research units themselves are largely housed in two easily expandable wings extending out from this central core.

To provide the maximum of flexibility and versatility of operation, the structure was designed with a ten-foot repeating module, with movable steel partitions. The various service connections—lighting, power, gas, compressed air, fume exhausts, etc.—are spaced every ten feet so that laboratory units can be spaced according to that module, and the size of individual laboratory rooms

Main Pilot Plant Building. At the rear is the Center's 150,000-gallon water storage tank.

Entrance to the Center, showing the Main Research Building in the background.

can be changed to include as many or as few of these units as desired.

Naturally, wide use was made of Armstrong's own floorings, insulation, acoustical materials and other products in the construction.

The Library and certain other portions of the building are air conditioned; some of the research areas are equipped so that temperature and humidity conditions can be closely controlled; and ventilating air, tempered and filtered, is provided for all occupied interior or windowless rooms and all rooms in which fume exhaust hoods are used.

Housed in the building are scores of individual laboratories equipped with thousands of instruments and devices for delving into almost every scientific field.

The Pilot Plant building, which is 150 feet wide and 240 feet deep, is equipped for the testing of laboratory devised processes on a semi-production scale, thus minimizing the necessity of interrupting factory operations for experimental runs. Also housed in this building is the Center's Power House, Machine Shop and Carpenter Shop.

Situated near the Pilot Plant Building is a separate building housing the Chemical Pilot Plant, and a unique structure called the Dual Temperature Laboratory. The latter, which is really a building within a building, was designed by Armstrong to provide facilities never heretofore available for experimentation with low-temperature insulation and related materials under almost any conceivable atmospheric conditions on earth.

Water and sewer lines to service the Center were laid by Armstrong 2¾ miles along the Lincoln Highway to connect with the Lancaster City system. An elevated tank stores 150,000 gallons of water at the site.

The Center was designed by the architectural firm of Shreve, Lamb and Harmon Associates of New York, with Charles S. Conrad, Jr., Chief Architect in Armstrong's Engineering Department, as the Associate Architect. Engineering aspects of the project were supervised by Armstrong's Engineering Department, headed by G. A. Reinhard, Jr., Chief Engineer. The general contractor was Henry E. Baton, Inc., of Philadelphia. Analyzing and planning for the new Center was carried out by the Armstrong research organization working with James Todd Baldwin, an architect on the Center's staff.

The work of the Center is organized along the same lines as the company itself, with four laboratory development groups corresponding to the four major selling divisions of the company: Glass and Closure, Floor Products, Building Materials and Industrial Products. Each of these divisional groups at the Center is responsibile for re-

The Library of the Armstrong Center, which carries on its shelves approximately 12,500 volumes and 125 scientific periodicals.

search, development and service for the products handled by the corresponding sales division.

In addition to these four "line" groups at the Center, there are two separate "staff" groups, Chemistry and Physics, which pursue basic lines of research applicable to all products in organic and inorganic chemistry; and electrical, mechanical, acoustical and other physical investigations.

Each of the divisional groups is divided into sections which concentrate upon specific products and processes. The number of such sections is fairly flexible, depending upon the type and the number of research projects being carried on at any given time, and upon other factors. Although each section nominally reports through a single divisional line, the activities of most sections cross divisional lines quite freely. For example, glass melting is combined with the work on insulating fire brick and mineral wool, which also involves high temperatures, in one section. Also, the glass section operates in close conjunction with the closure section, since many of the problems of these two units are intimately related.

While routine analysis and checking of raw materials for glass is done at the plant laboratories at Millville and Dunkirk, the Center is equipped to make special analyses of glass ingredients as required from time to time. For making these analyses, the Center has a modern "wet" analytical laboratory, as well as diffraction spectrograph, X-ray diffraction apparatus and infrared spectrograph. This same equipment can be employed for analysis of finished glass, especially to determine the presence of minute quantities of material not likely to be found in routine tests, such as traces of lead and coloring material like chromium which may occur through the use of cullet. The Center is also equipped to check, when necessary, the chemical durability tests which are commonly conducted at the plant laboratories, based on techniques developed at the Center.

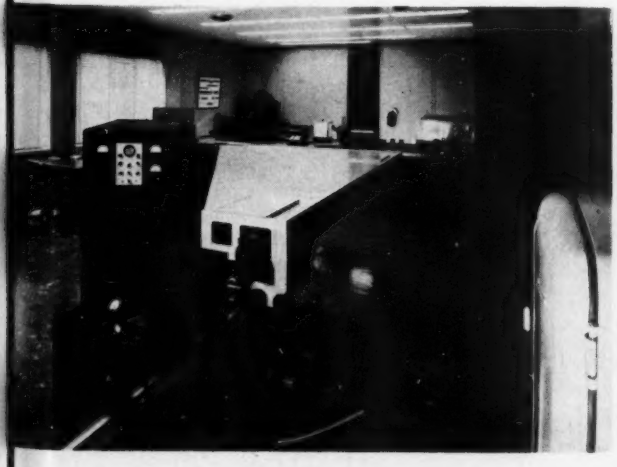
For experimental melts, the Center has a gas-fired cylindrical furnace of a design developed by Armstrong. Several electric furnaces are used for annealing and other heat-treating studies. The furnaces are program operated from a control panel.

For color studies of glass in the visible range of light the Center has a G. E. recording spectrophotometer and, for use in the ultraviolet range, a Beckman quartz spectrophotometer. For making thermal expansion measurements, the Center is equipped with an interferograph, one of very few of its type in this country. Developed by the United States Bureau of Standards, this instrument combines the convenience and accuracy of a conventional interferometer with photographic recording of results. A research petrographic microscope is one of several types available at the Center to supplement the simpler microscopes used in the plant laboratories.

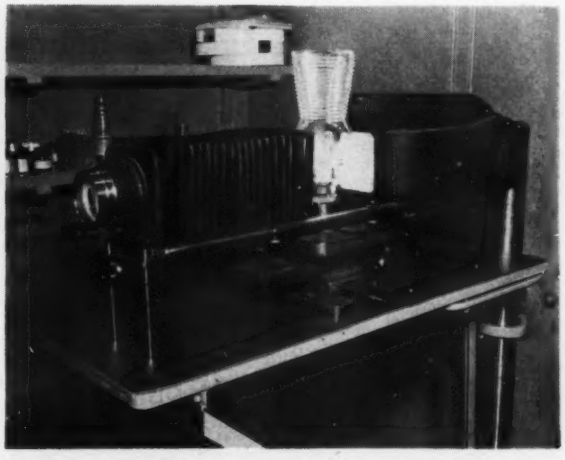
One of the organic chemistry units at the new Center.

The Center's numerous test rooms, which provide a wide range of temperature and humidity conditions, are available for studying the weathering of glass, carton strength and closure performance, under virtually all climatic conditions. In the Dual Temperature Laboratory, previously mentioned, extremes of temperature ranging from —100 degrees F. to 200 degrees F., and a full range of humidities, can be produced. This Dual Temperature Laboratory was constructed primarily because insulation is one of the company's prime interests.

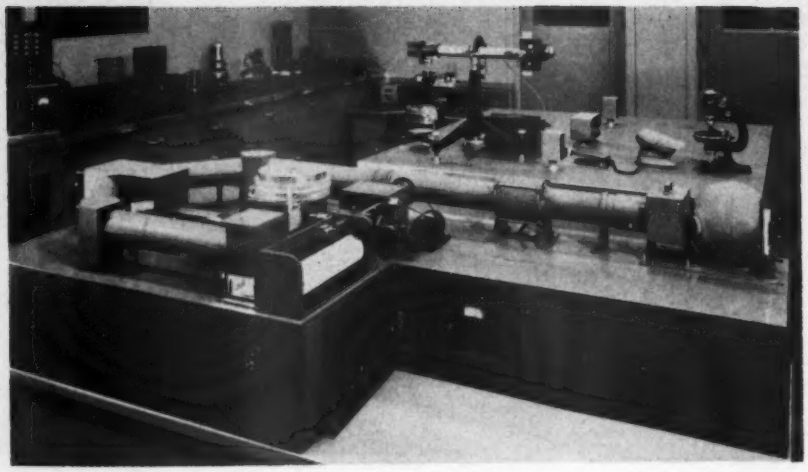
Strength testing equipment at the Center, which is oc-



Grating spectrograph used in making analyses of raw materials, as well as finished glass.



Projectoscope at the Research and Development Center used to throw the image of a bottle, magnified ten times, on a screen to facilitate study of the finish.



G. E. recording spectrophotometer, with interferograph and petrographic microscope in the background.

casionally used for tension and compression tests on glass, includes an Instron machine and a Baldwin-Southwark Universal Tester, the latter capable of exerting loads from one-half pound to 120,000 pounds. One piece of equipment, which the glass section at present is using a great deal, is a modern automatic calculator, which is employed in the development of statistical quality control procedures. A prized possession of the glass section is a library of hundreds of glass samples assembled over a period of years. Each sample is labeled with details of composition and melting conditions, and the collection is fully indexed for ready reference.

The subject of glass and ceramic products generally is, of course, well represented in the approximately 12,500 volumes and 125 scientific and technical journals carried on the shelves of the Center's modern and spacious library. All the standard chemistry and physics texts and reference works in English, German and other languages are included.

As has been indicated, the Center's work in the glass field is closely coordinated with its activities on other ceramic products and with the work of the closure section. Since the success of a glass container depends, to a considerable extent, on closure performance, the glass section's familiarity with closures is an invaluable aid; while an intimate knowledge of glass and bottle-making procedures facilitates the task of the closure section, which makes thousands of tests annually to determine the best closure and the best combination of closure, liner and liner facing for particular products. Both the glass section and the closure section gain also, in varying degree, from the work done in other sections, notably the plastics section and the paint section.

These intimate, interconnected relationships exist throughout the Center. They increase the effectiveness of Armstrong research generally and help to weld the staff, which numbers 285 men and women assembled from many states and some foreign countries, into a smoothly functioning team. The staff is headed by Edmund Claxton, Research Director, who also is a member of the company's board of directors; F. B. Menger, Associate Director, and R. B. Rohrer, Assistant Director. The work of the glass and closure group is directed by E. C. Emanuel, K. C. Lyon and John M. Sharf.

Weighing batch ingredients for an experimental glass melt.

BATTELLE FOREIGN EXPANSION

The cornerstone for a new research center at Frankfurt-Main, Germany, to serve the industry of that country, was placed recently. The new Battelle Memorial Institute for Germany is being established by Batelle Memorial Institute of Columbus.

Simultaneously, Battelle Director, Clyde Williams, announced that Battelle is establishing another research center at Geneva, Switzerland, and has set up a program of fellowships for selected students in the universities of both Switzerland and Germany. In addition, research centers and fellowship programs for other countries of Western Europe are contemplated for the future.

• Glass Fibers, Inc. has joined the Industrial Mineral Fiber Institute. It is the eighteenth member of the association. R. W. Capaul, Vice President and General Sales Manager, and F. J. Solon, Jr., Vice President of Advertising and Public Relations, represent the firm at association conferences.

COLORATION OF GLASS BY RADIATION

By KUAN-HAN SUN and NORBERT J. KREIDL

PART III

Thermoluminescence

Thermoluminescence is the phenomenon that relates to the emission of visible or uv light upon heating or infrared illumination. This is not a violation of the law of the conservation of energy. The low energy heat radiation is not converted into high energy light radiation, but, rather, it merely "triggers" the emission of light. The energy available was already stored in glass by the preceding exposure to high energy radiations, such as ultraviolet rays, x-rays, and nuclear radiations. The mechanism may be interpreted as follows: The free electrons created by the nuclear or other radiations move in glass until they are trapped in some "impurity" levels. The system is still in an excited state. It does not radiate, because it happens to be in the meta-stable level. Now, if a small amount of energy, such as that from heat energy, is supplied, it will raise the electrons to a slightly higher level which is then capable of jumping down to much lower level with the emission of light. Thermoluminescence results. Since this process of thermoluminescence is very closely related in mechanism and in practical applications with that of discoloration, it is given a special section here.

The phenomenon of thermoluminescence was observed in glass samples irradiated with atomic radiations almost as early as that of coloration. More detailed studies were of later date. Hoffmann[89], for example, studied a number of phosphate glasses which turned red under radium irradiation. When these glasses were than heated to about 120-150°C., brilliant luminescence of yellowish red almost visible in daylight was observed. The color in glass produced by the radiation previously disappeared at the same time. When the glass was re-exposed to radiation, coloration resulted once more. The cycle could be repeated many times. Perhaps, one of the most interesting studies was that by Nyswander and Cohn[123]. These investigators found that glasses having turned violet by long exposure to sunlight were thermoluminescent when heated to temperatures above 100°C. Some glasses exposed to sunlight showed the phenomenon of thermoluminescence before the violet coloration appeared. Thermoluminescence could be detected in a glass exposed only two days in sunlight while coloration needed exposure of about two weeks. This agrees with the early findings of Lind and others[103-105] using radiations from radium. It is clear that the thermoluminescence is a much more sensitive process than that of coloration. Nyswander and Cohn also adopted a base glass composed of 45.5 ZnO and 54.5 boric acid for the study of thermoluminescence. A series of glasses was prepared by adding a trace of Mg, Ca, Sr, Ba, Al, Mn, Ni, Co, Cr, Ce, Ag, Tl or Th (all as oxide) to the base glass. After the exposures of these glasses to the carbon arc which was found to color glasses in a few minutes and to be much more efficient than sunlight in producing coloration, they were tested for thermoluminescence. The most intensely luminescent ones under heating were those containing Th, Ce, Ag, Cr, Co and Mn. The glass containing 0.59 per cent Th was so sensitive that 20 minutes exposure to the sunlight was sufficient to render it thermoluminescent by heating it at 135°C. Yet, the glass was not colored even after 100 minutes exposure under the arc lamp. This again indicates that the phenomenon of thermoluminescence is a much more sensitive process than that of coloration for the detection of the presence of radiations. The thermoluminence of the Th-containing glass found to have no connection with the slight radioactivity that is inherent in Th. The duration of thermoluminescence usually varies with the types of glass. For the glasses investigated by these authors, the half life of decay was about 12 seconds. Nyswander and Lind[124] observed the thermoluminescence from a glass previously exposed to radon by heating it to about 130°C. They found that the thermoluminescence was still noticeable by heating the glass three years after it was exposed to radiations. The intensity of luminescence was almost 40 per cent of that found four months after irradiation. They also found no heat radiations accompanying the thermoluminescence. Cohn[199] found the maximum thermoluminescence in a zinc borate glass with the empirical formula, $5ZnO.4B_2O_3$, when 0.2% manganese was present. He also noted that the glass with 2% manganese yields fluorescent spectra with a maximum at 6100A upon excitation by ultraviolet radiations. The emission spectra of fluorescence and of thermoluminescence were found alike, which is indeed a very interesting phenomenon. Cohn and Lind[201] found that radium irradiation of a similar glass increases the ultraviolet absorption which was claimed to be closely related to the thermoluminescence. Daniels and Saunders[49] have presented a comprehensive report on the thermoluminescence of crystals. Minerals are shown to exhibit the phenomenon due to the irradiation by natural radioactivities in earth. Daniels[198] has designed a dosimeter badge made of a lithium fluoride crystal which is capable of emitting dim light upon receiving 10-50r when the crystal is heated on a hot plate well under red heat. Perhaps the most sensitive thermoluminescent dosimeter is that reported by Friedman and Glover[202] which is capable of detecting 0.1r. It is a Ag-activated NaCl crystal which emits ultraviolet light upon heating to about 150°C. It is not impossible that the limit of dosages may be reduced further in future development.

In view of the fact that thermoluminescence seems to be a very sensitive process and some of the meta-stable levels seem to have a lifetime in the order of years, it would be advisable to investigate the process further to see if the process is a linear function of radiation dosage and to see if a more sensitive glass may be developed for the purpose of dosimetry. The glass dosimeter is superior because of its low cost in casting larger pieces. It may be worthwhile to repeat some experiments of Cohn and his collaborators, particularly now that modern techniques of detecting luminescence have been improved tremendously in sensitivity through the introduction of photomultipliers. The early glasses may be also sensitive to ultraviolet irradiations, which will render them useless as a dosimeter for nuclear radiations. This can

be remedied by coating the glass with a layer of ultraviolet absorbing material. It might be possible that the thermoluminescence is stronger in crystals than in glasses. The infrared phosphors, such as SrS-CaS activated with Eu, Sm, etc., developed during the World War II might appear to be more sensitive than those found in glass. A glass into which these phosphors are embedded should also be studied in the search for a more sensitive dosimeter. It should not be surprising if a dosimeter sensitive to a fraction of a γ-unit may emerge through further investigations.

Discoloration by Other Mechanisms

Undoubtedly there are other mechanisms that have not been considered here that may be responsible for the discoloration of glass by radiations. Otley and Weyl[125], for example, found that a blue poly-sulfide-containing borate glass faded easily under irradiation by x-rays or γ-rays. They seem to attribute the color to the easy polarizability of the sulfide ions. Weyl[198] emphasizes the strong polarization effect of some ions which produces an asymmetrical force field which in turn leads to the strong absorption of photons or light resulting in coloration or discoloration. In a later paper[207], however, they attribute the blue color to S_2 molecules with a broad absorption band of 5000-6000 A. The fading of color on exposing to radiations is interpreted as due to trapping of one or more electrons by S_2 molecules to form sulfide ions.

Concluding Remarks

In closing, it may be appropriate to state that what we know on the subject is very little, and what we ignore, immense. Further investigations may not materially alter the situation. But they will at least help us to clear our vision toward the infinite horizon.

Acknowledgment

The authors are indebted to Drs. G. S. Monk[1], J. H. Schulman[2] and W. A. Weyl[3] for various stimulating discussions on the subject; and they are indebted to the Bureau of Ships for the release of this first report under a contracted study.

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RECENT TRANSLATIONS OF RUSSIAN PAPERS OF INTEREST TO THE GLASS INDUSTRY

Abstracts of five papers which appeared in the Russian journal of the glass and ceramic industries.

SHEET GLASS WITHOUT DEBITEUSE

Several glass works in Russia now draw sheet glass from uncinfined surface of glass melt. F. G. Solinov and I. O. Tomashevich report some observations on this process in *Steklo i Keramika* (Glass and Ceramics) 1951, No. 9, p. 5-8.

To obtain a sheet whose thickness remains uniform along all its width, it is necessary that the temperature be constant over the melt surface from which the sheet is lifted. The surface temperature near the center of the drawing chamber is about 30°C. higher than near the walls, if the mean temperature is between 930°C. and 980°C. The effect of such a large temperature difference on surface tension and viscosity of molten glass is so considerable that the edges of the sheet have a thickness significantly different from that of the middle.

To obviate this difficulty, horizontal screens are suspended over the surface of the melt. Each screen has a spindle-shaped opening through which the glass sheet is drawn upward. The opening is made spindle-shaped because the melt loses more heat under wide than under narrow parts of the opening; thus the center of the drawing chamber cools to the temperature of its periphery, and the sheet becomes more uniform.

Fig. 1.

Fig. 1 shows the approximate shape of the opening which resulted in the most uniform temperature distribution for the particular conditions of the furnace studied by Solinov and Tomashevich. The ratio of the greatest clearance H to the smaller clearances h depended on the distance a from the apex as follows:

a cm.	$H:h$	a cm.	$H:h$
5	3.6	40	1.35
10	2.6	45	1.3
15	2.25	50	1.25
20	2.0	55	1.2
25	1.75	60	1.15
30	1.5	65	1.10
35	1.4	70	1.05
		75	1.0

The screens are made of a mixture of 1 part of clay and 4 parts of ground asbestos, in which an iron lattice is embedded. Each half of the screen is attached to a cooling tube parallel to the axis of the spindle.

The screens must be suspended in truly horizontal position 2 to 4 cm. above the melt surface. It was sufficient to lift them to a position 8 cm. above the surface to make the drawing of glass sheet impossible.

PERFORMANCE OF GLASS FOAM FURNACES

D. B. Ginzburg and N. I. Fateeva studied the performance of a production unit in which foam glass was being manufactured. The results were published in *Steklo i Keramika* (Glass and Ceramics) 1951, No. 9, p. 11-13.

Two ovens are needed for this production. The first is the sintering, and the second is the annealing oven. Through each oven a conveyor belt passes. It separates each oven into the upper ("working") and the lower ("burner") channels. Metal molds filled with batch are carried on the conveyor belt in the sintering oven, while in the annealing oven blocks of foam glass are annealed and cooled to room temperature.

The sintering oven is shown in elevation in Fig. 1. It consists of 3 consecutive zones in which, respectively, heating-up, sintering and cooling occur. In the first two zones, nine burners are present. They burn producer gas from anthracite. Neither the gas nor air are preheated. The burners are situated on both sides of the lower channel. The hot combustion gases rise in vertical ducts in the oven walls, sweep over the upper channel and escape through the chimney. The cooling zone has no burners. Along its ceiling and floor hollow cast iron ducts are arranged. Cool air is forced through these ducts by a fan.

As is seen from Fig. 1, the total length of the sintering oven is 17 meters. Its height is 50 cm. at the start of the preheating zone, 61 cm. in the sintering zone and the adjacent part of the preheating zone, and 36 cm. in the cooling zone. The width of the first two zones is 139 cm. and of the cooling zone, 120 cm.

The time spent by the charge in the different zones is indicated in Fig. 1. Also indicated are the prescribed temperatures (I, solid line) and the temperatures actually recorded by Ginzburg and Fateeva (II, dashes). The hottest place of the oven has 860°C. All temperatures are in °C.

The annealing oven consists of two consecutive zones. The first one is 6 meters long, see Fig. 2, and contains 4 burners in the lower channel. The combustion gases are mixed with cold outside air and led over the charge which moves with the conveyor belt. Then they are pumped away through two pipes extended along the second zone. This zone contains no burner, and cold air is sucked into it through narrow openings in the roof and also through the end orifice.

The annealing oven is 26 meters long and 210 cm. wide, and the upper channel is 45 cm. in height. The prescribed (solid line, I) and the actual (dashes, II) temperatures agree well, see Fig. 2. It is to be noted that cooling below 455-470° is more rapid than between 635° and 455-470°C.

The sintering oven is charged with 120-140 molds. Each contains 6-7 kg. of batch. The resulting foam glass block are 38 cm. x 47.5 cm. x 12 cm. large.

The composition of the producer gas was CO_2 5%, O_2 0.2%, CO 28.1%, H_2 9.2%, CH_4 1.6%, N_2 55.9%. The sintering oven consumed 500 cubic meters of this gas every hour. The composition of the exhaust gases was CO_2 5.0%, O_2 14.0%, N_2 80.0%. The annealing oven consumed 100 cubic meters of producer gas per hour.

Table I presents the heat balance sheet of the sintering oven. It assumes that the molds, when entering the oven,

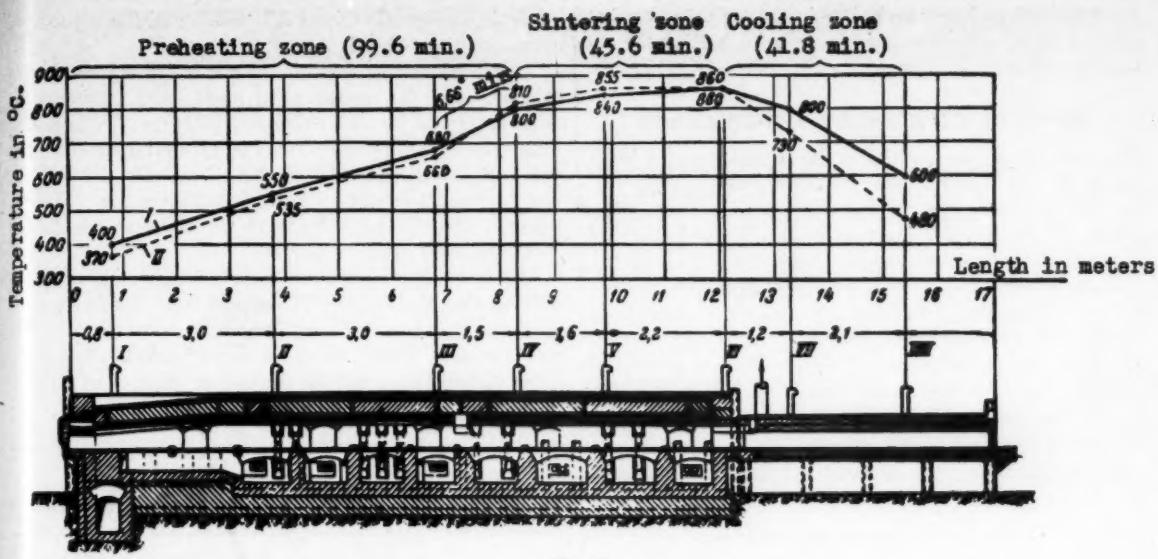

Fig. 1.

have the temperature of 300°C. and, when leaving it, that of 600°C. and that the temperature of the exhaust gases is 355°C. The heat quantities listed in the table refer to one hour of steady working.

TABLE I

Supply and loss of heat in the sintering oven per hour.

Heat Supply	Kg.cal./hour	%
Heat of combustion of the fuel	604 400	86.53
Heat content of the fuel	1 090	0.15
Heat content of the air	16 348	2.35
Heat content of the batch	401	0.06
Heat content of the molds and lids..	70 000	10.00
Others	6 318	0.91
Total	698 557	100.00
Heat Loss		
Heat content of the blocks	14 625	2.09
Heat content of the molds and lids..	158 000	22.62
Heat content of the exhaust gases ..	341 910	48.95
Loss through walls and crown	117 300	16.80
Loss by radiation	4 622	0.66
Others	62 100	8.88
Total	698 557	100.00

The supply and loss of heat in the annealing oven, shown in Table II, is calculated under the assumption that the temperature of the entering foam glass blocks is 550°C., of the outgoing blocks 25°C., and of the exhaust gases 172°C.

TABLE II

Supply and loss of heat in the annealing oven per hour.

Heat Supply	Kg.cal./hour	%
Heat of combustion of the fuel	120 880	87.95
Heat content of the gas	218	0.16
Heat content of the air	5 015	3.64
Heat content of the blocks	11 340	8.25
Total	137 453	100.00
Heat Loss		
Heat content of the blocks	42	0.03
Heat content of the exhaust gases ..	48 138	35.05
Loss through walls and crown	58 900	42.85
Others	30 373	22.07
Total	137 453	100.00

The expenditure of heat is 300 000 kg.cal. for every cubic meter of foam glass. This is an excessive amount.

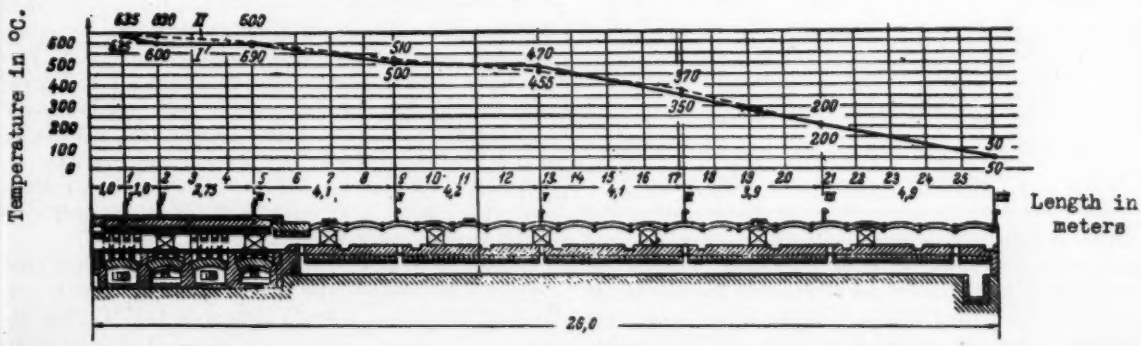

Fig. 2.

The waste of fuel may be reduced, e.g., by using the hot exhaust gases of the sintering furnace for heating the annealing oven.

DEFECTS IN RUSSIAN SHEET GLASS

The Institute of Glass, which is the central research institution for the Russian glass industry, made a survey of the defects appearing in the sheet glass of five glass plants. M. P. Savitskii summarized the results in *Steklo i Keramika* (Glass and Ceramics) 1951, No. 5, p. 9-13.

Glass sheets were placed vertically and viewed from one meter distance. The defects noticed were sifted in six classes and 17 sub-classes, and their frequency was referred to one square meter of sheet. Table I shows the classification used, the results that were obtained in the best and the worst plant, and also some average results. Altogether 829 sheets were inspected.

TABLE I

Number of defects on square meter.

	Plant B	Plant D	Average of All Plants
1. Air bells			
under 3 mm.	14.0	6.3	
4- 6 mm.	1.0	0.5	
7-10 mm.	0.7	0.1	
11-15 mm.	0.3	0.1	
over 15 mm.	none	none	
all air bells	16.0	7.0	9.1
2. Alkali bubbles			
under 3 mm.	2.8		
4-6 mm.	0.6		
over 6 mm.	0.4		
all alkali bubbles	3.8	none	1.7
3. Inclusions			
under 2 mm.	10.5	0.2	
3-4 mm.	0.6	0.3	
5-6 mm.	0.1	0.1	
over 6 mm.	0.8	0.1	
all inclusions	12.0	0.7	4.6
4. Devitrified patches			
under 3 mm.	1.3	0.04	
over 3 mm.	3.5	none	
all devitrified patches	4.8	0.04	2.2
5. Schlieren	none	0.2	0.2
6. Scratches			
under 5 mm.	none	0.1	
6-10 mm.	0.4	none	
over 10 mm.	none	none	
all scratches	0.4	0.1	1.4
Total	37.0	8.0	19.2

The frequency of defects varies also from machine to machine belonging to the same glass tank. Thus in the sheets taken from 3 machines of Plant B, the number of air bells varied from 15.1 to 17.3 per square meter, the number of inclusions varied from 3.7 to 18.3, the number of devitrified patches from 2.3 to 6.6, and the number of scratches from 0.1 to 0.5.

The frequency of inclusions and devitrified patches is greater when the molten glass feeds one machine after another (in series) as compared with the "immediate" system in which the machines are grouped around a central well and directly receive glass from this. In the second system there were 9-17 inclusions (in two different plants), while in the first system the frequency was 22-28 inclusions on a square meter.

The frequency is referred to as unit area. However, it is clear that the number of many defects should be proportional to the volume of the glass rather than to its area. In other words, the frequency of defects per square meter should be greater the thicker the glass sheet. Table II shows that this expectation was confirmed.

TABLE II

Frequency of defects per square meter. Plant D.

	Sheet thickness in mm.				
	6.5	5.5	4.5	3.0	2.2
Air bells	8.1	2.9	5.1	4.6	3.8
Inclusions	1.3	3.0	0.8	1.3	0.7
Total	9.4	5.9	5.9	5.9	4.5

The results of the survey will be used in the next revision of the Russian standard for sheet glass.

ALUMINA-MAGNESIA GLASS CONTAINING POTASSIUM

I. I. Tukh and K. I. Tugusheva report, in *Steklo i Keramika* (Glass and Ceramics) 1951, No. 4, p. 7, successful experiments on the introduction of potassium in a glass whose original composition (caluculated from the batch) was:

SiO_2 72.7%, Al_2O_3 0.9%, Fe_2O_3 0.16%, CaO 8.5%, MgO 3.5%, Na_2O 14.5%

In the new glass, 1.5 part of K_2O was substituted for 1 part of Na_2O. The new batch consisted of:

Sand	73.80	Sodium carbonate	23.30
Potassium carbonate	2.46	Sodium sulfate	1.21
Dolomite	16.20	Limestone	5.84
Coke	0.07	parts	

to make 100 parts of glass.

The batch was ground until the main fraction of each component had grains between 0.1 and 0.3 mm. in diameter, except for the dolomite, which was finer. Potassium carbonate was first separately mixed with the sand. This was done because sand grains coated with a potash layer melt more easily and the resulting melt has lower viscosity than is the case in the usual batch. Two other mixtures were prepared: (a) dolomite + limestone + sodium carbonate, and (b) coke and sodium sulfate. Then (a) and (b) were mixed with the sand-potash powder previously wetted with 5% water.

Compared with the original, the new batch required lower melting temperatures. Thus, the temperature before the first burner was 1325°C. instead of 1345°C., that be-

(*Continued on page* 672)

Inventions and Inventors

Annealing and Tempering

Lehr Loader. Fig. 1. Patent No. 2,612,256. Filed November 9, 1946. Issued September 30, 1952. Three sheets of drawings. Assigned one-half to Henry C. Daubenspeck and one-half to Samuel E. Winder by Harold A. Youkers.

A new spacing mechanism for bottles is shown in Fig. 1. The objective of the apparatus is to space bottles moving relatively rapidly, or at spacing intervals that are relatively short, so that the lehr loader can properly remove one bottle before a subsequent one would strike the same. Each bottle is loaded onto the conveyor at position F and is moved to the right side of the conveyor by deflector 30. As the bottle strikes deflector gate 33, it will be held back momentarily and at the same time deflected across the conveyor to the corner between the gate 33 and 34. At this point, it will be retained until the proper release time. If the bottle D, as shown in Fig. 1, approaches and moves approximately into contact with gate 33, both gates are opened so that both bottle D and bottle E (following) may be released as a pair and thus avoid contact and sticking due to the temperature of the glass. The desired respacing is thus accomplished at gates 33 and 34.

The gate operation is timed by the rotary air line timing valve mechanism 95 (not shown), which is operated to connect the air pressure line 96 (not shown) to the lines 90 and 91.

The patent contains 13 claims and the references cited were: 1,292,178, Waterman, Jan. 21, 1919; 1,427,325, Quick, Aug. 29, 1922; 1,579,545, Lansford, Apr. 6, 1926; 2,047,406, Copping, July 14, 1936; 2,059,177, Ohrn, Oct. 27, 1936; 2,273,509, Braren, Feb. 17, 1942; 2,350,479, Stewart, June 6, 1944; 2,451,104, Lowe, Oct. 12, 1948; and 818,058, France, June 7, 1937.

Glass Compositions

Alkali Resistant Glass. Patent No. 2,615,817. Filed October 18, 1950. Issued October 28, 1952. No Drawings. Assigned to General Electric Company by John Edwin Stanworth and Alan Edward Dale.

Glasses capable of resisting attack by sodium vapors have been developed. Such glasses have particular application as envelopes for electric discharge lamps. Corrosion with such lamps is quite severe as in their operation an alakli metal is vaporized and the glasses must be capable of resisting attack by such vapors. Other requirements of the glass are that their coefficient of thermal expansion should be comparable to those glasses used in other portions of the envelope.

Suitable glasses have been found within the following range of compositions (percentages by weight):

P_2O_5	13-20
B_2O_3	35-46
Al_2O_3	20-29
CaO and/or MgO and/or BaO more than	15
SiO_2, less than	10

The above glasses are recommended for use with the following borosilicate glass (percentages by weight):

SiO_2	66
Al_2O_3	2
B_2O_3	24
Alkalies	8

The composite glass tubing as described above possess a thermal expansion characteristic of about 50×10^{-7} and is suitable for forming metallic seals.

The patent contains two claims and the references cited were: 1,547,715, Baker, July 28, 1925; 2,030,389, Navias, Feb. 11, 1936; 2,030,390, Navias, Feb. 11, 1936; 2,030,397, Reynolds, Feb. 11, 1936; 2,100,391, Grimm et al., Nov. 30, 1937; 2,240,352, Schmidt et al., Apr. 29, 1941; 2,466,849, Hood, Apr. 12, 1949; and 461,570, Great Britain, Feb. 19, 1937.

Glass Wool and Fiber

Forming Glass Fibers. Fig. 2. Patent No. 2,609,566. Filed December 31, 1948. Issued September 9, 1952. Four sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by G. Slayter and C. J. Stalego.

An improved method for making fiber glasses of one to five microns in diameter is presented. The method is less susceptible to accidental interruptions in forming and is thus capable of continuous operation. The principle involved is best understood by referring to Figure 2. Molten glass from the forehearth 62 flows by gravity through tubes (not shown) to the top surface of rotor 28. The glass deposited in the annular recess 66 in the rotor 28 is more or less uniformly distributed throughout the

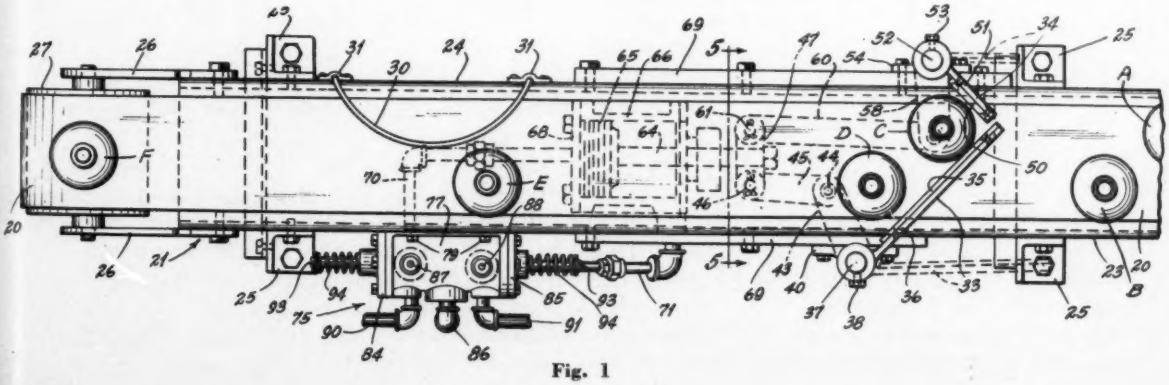

Fig. 1

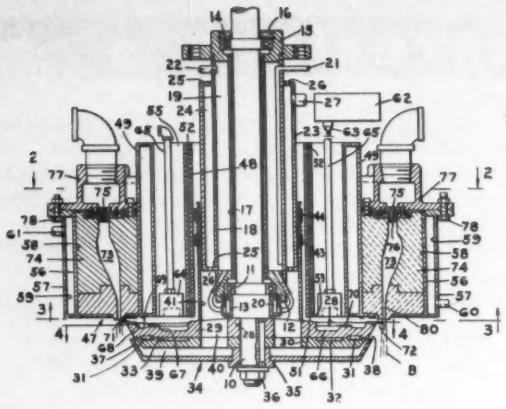

Fig. 2

recess as the rotor revolves about the axis of the shaft 10 and is heated by radiant burners 64. The molten or heat softened glass is further subjected to the centrifugal force resulting from the rotation of the rotor and flows radially outward over the annular serrated edge of flange 68. The glass is separated into a multiplicity of individual streams which are drawn out by the action of centrifugal force to provide filaments 72. At this point the primary filaments are projected into an intensely hot high velocity blast B where they are drawn down or attenuated into fine fibers. They may be collected in the form of a mat, if desired, on a conveyor (not shown) supported below the apparatus.

The patent contains 12 claims and the references cited were: 2,192,944, Thomas, Mar. 12, 1940; 2,328,714, Drill et al., Sept. 7, 1943; 2,338,473, Von Pazsiczky, Jan. 4, 1944; 2,450,363, Slayter et al., Sept. 28, 1948; 215,-101, Switzerland, June 15, 1941; and 571,807, Germany, Mar. 6, 1933.

Fiber Glass. Figure 3. Patent No. 2,605,503. Filed July 28, 1950. Issued August 5, 1952. One sheet of drawings. Assigned Johns-Manville Corp. by Edward R. Powell.

This patent is a continuation of application S. N. 118,-815, filed September 30, 1949. This procedure for making fine fibers of glass is best understood by referring to Figure 3. Glass of suitable composition and finely ground (60-100 mesh) is fed into hopper 50 and subsequently discharged through the nozzle 54 by a combination of gravity and suction of the blast from the burners. The particles are picked up by rotor 10 to form a layer of glass on its surface. Later, by contact with rotor 22 and the points 26, fibers are elongated and separated from the surface of 10. The fibers thus formed are picked up by a disc 62 which directs them downward and ultimately onto a conveyor 72 for collection and removal.

The patent contains 17 claims and the following references were cited: 1,617,166, Schoop, Feb. 8, 1927; 1,756,381, Pahl, Apr. 29, 1930; and 2,385,358, Hanson, Sept. 25, 1945.

Temporary Bond for Glass Fibers. Patent No. 2,607,-714. Filed November 1, 1946. Issued August 19, 1952. No drawings. Assigned to Owens-Corning Fiberglas Corporation by Clayton A. Smucker.

Temporary binders are desirable for binding glass fibers used in tower packings, battery separators and

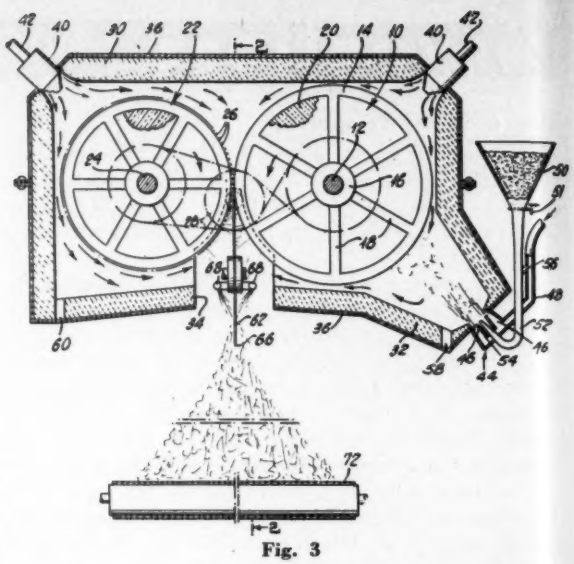

Fig. 3

insulation in order to prevent disintegration of the fiber matts prior to installation or use. For this purpose suitable resinous water soluble adhesives have been developed. They consist primarily of modified cellulose ether derivatives, such as methyl cellulose, benzyl cellulose, or the like-solutons containing 10-40 per cent cellulose in water and applied to the fibers by spraying are desirable. The patent contains 16 claims and 10 references were cited.

Reinforced Plastics. Patent No. 2,611,718. Filed March 14, 1947. Issued September 23, 1952. No drawings. Assigned to Owens-Corning Fiberglas Corporation by Robert Steinman.

Certain complexes of the Werner type properly applied to the surfaces of glass fibers, employed to reinforce plastics, greatly aid in maintaining the strength properties of the reinforced plastic in the presence of moisture. According to Iler (No. 2,273,040), Werner-type compounds are complexes in which a trivalent nuclear chromium atom is coordinated with an acyclic carboxylic acido group having at least ten carbon atoms.

Examples of fiber-treating compositions that may be applied by dipping or spraying are as follows:

EXAMPLE I	*Per cent*
Polyvinyl acetate emulsion (50% solids)	5
Methacrylato chromic chloride (6% base solution)	2
Water	93

EXAMPLE II	*Per cent*
Polybutyl methacrylate (50% water dispersion)	15
Furfurylacrylato chromic chloride (6% base sotion)	5
Water	80

The fibrous material thus treated is then combined with synthetic resins or plastics in the conventional manner. Allyl type resins have given the best results.

The patent contains six claims and the references cited were: 2,273,040, Iler, Feb. 17, 1942; 2,341,885, Sowa, Feb. 15, 1944; 2,356,161, Iler, Aug. 22, 1944; and 2,544,-666, Goebel et al., Mar. 13, 1951.

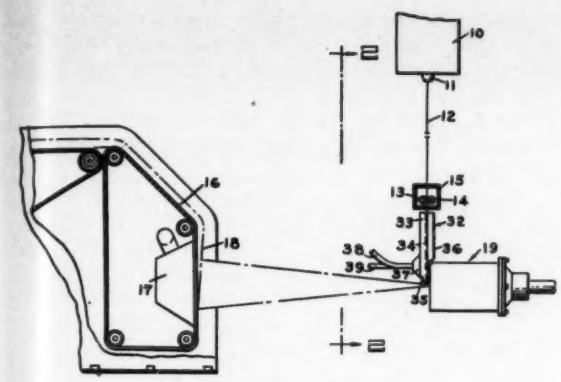

Fig. 4

Apparatus for Producing Fine Glass Fibers. Fig. 4. Patent No. 2,607,075. Filed March 28, 1947. Issued August 19, 1952. Four sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego.

Glass fibers as small as one micron and even less have been produced by this method. In Fig. 4 molten glass flows in small streams from orifices 11 and are attenuated to form primary filaments or fibers 12 by means of the rolls 13 and 14. The primary filaments are projected into a gaseous attenuating blast at a quite high temperature (2900°F.). Secondary fibers are formed from the blast of burner 19 and are subsequently built up into a unitary mat 18 on the conveyor 16. A suction chamber 17 located at the rear side of the conveyor 16 aids in the development of the mat. A high velocity blast is necessary to form the secondary fibers. This is accomplished by burning a combustible gaseous mixture in an enclosed chamber and exhausting the products of combustion through a restricted orifice which guides and accelerates the gases to form an intensely hot high velocity blast. Full appreciation of the many controlled features of the process can be understood only after a careful study of the many drawings.

The patent contains 25 claims and the references cited were: 1,157,984, Herkenrath, Oct. 26, 1915; 1,328,446, Odam, Jan. 20, 1920; 2,175,225, Slayter, Oct. 10, 1939; 2,227,357, Martin, Dec. 31, 1940; 2,457,777, Holtschulte et al., Dec. 28, 1948; and 2,499,218, Hess, Feb. 28, 1950.

Sheet and Plate Glass

Double Glazing. Fig. 5. Patent No. 2,612,663. Filed February 6, 1947. Issued October 7, 1952. One sheet of drawings. Assigned to Libbey-Owens-Ford Glass Company by John P. Pearse.

In mounting double-glazed units, particularly large sized units, unevenness in the sill, either transversely or longitudinally, tends to cause rupture of the seal or breakage of the glass. In order to overcome this difficulty of setting, blocks 21 and 20 are provided as shown in Fig. 5. The lower block 20 is provided with a longitudinally extending groove 22 that receives a tight-fitting tongue that is a part of the upper block 21. When the double glazing unit 10 is rested upon the top member 21 in a vertical position, the top member will automatically adjust itself transversely so that the upper surface thereof will engage the lower edges of both of the glass sheets. The sill 17 may also not always be perfectly level longitudinally of the window opening, and in order to compensate therefore, the bottom surface of 21 is longitudinally curved so that the block is thickest at its longitudinal center and becomes progressively thinner toward opposite ends. Because of this, the block cannot only rock transversely upon the tongue 23 but likewise longitudinally to automatically adjust itself to any variations in the sill or sill plate.

The patent contains four claims and the following reference is cited: 896,431, Boermel, Aug. 18, 1908.

Tube and Cane Machines

Reshaping Tubing. Fig. 6. Patent No. 2,615,285. Filed November 1, 1951. Issued October 28, 1952. Two sheets of drawings. Assigned to General Electric Company by Robert E. Gosnell and Adrien F. Casler.

Tubular fluorescent and incandescent lamps as used today are provided at each end with a basing collar of reduced diameter for mounting. It is necessary that these collars be of uniform dimensions and concentric with the rest of the tube. Apparatus for reshaping such tubes is shown in Fig. 6. The glass tube 1 to be reshaped in an indexing conveyor or turret is introduced at A. The conveyor moves the tube in a horizontal position through a succession of heating stations B, C, D, E, F where the ends of the tubes are heated to a softened workable condition and rolled inwardly to form end collars of re-

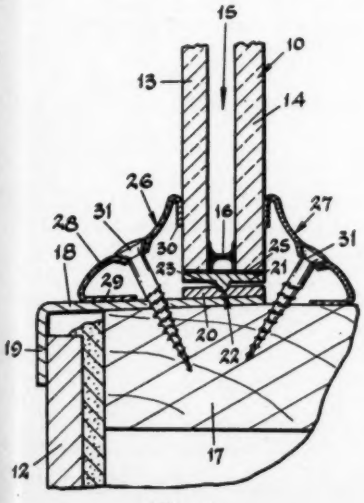

Fig. 5

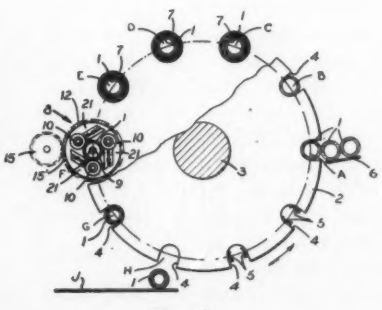

Fig. 6

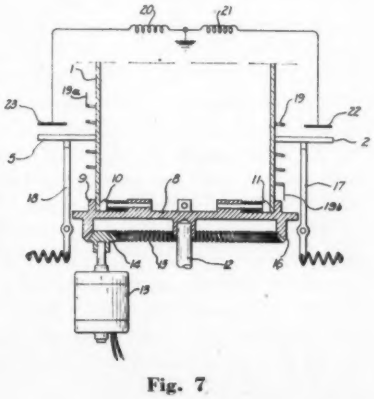

Fig. 7

duced diameter, after which the reshaped tubes are discharged at H. The glass tubes are held in a horizontal position by recesses 4 and jaws 5 shown on the periphery of turret 2. Gas burners 7 are provided at each station. The detailed accomplishments of the apparatus can be appreciated only after studying the several drawings.

The patent contains three claims and the references cited were: 2,284,089, Hahn et al., May 26, 1942; 2,364,673, Stuckert et al., Dec. 12, 1944; 2,394,115, Snyder, Feb. 5, 1946; and 2,470,923, Fisler, May 24, 1949.

Cutting Glass Tubes. Fig. 7. Patent No. 2,615,286. Filed August 31, 1948. Issued October 28, 1952. One sheet of drawings. Assigned to General Electric Company by Maurice Descarsin.

This invention is a continuation of Patent No. 2,385,567 and shows the application of high frequency technique to the cutting of glass tubes. With tubes of larger diameter it is difficult to bring about uniform preheating of the line of cut, and dissipation of heat away from the proposed line of severance is objectionable. Details of the cutting apparatus are shown in Fig. 7.

Glass tube 1 is held in place by tension of springs 10 and 11, as well as rotatable discs 2 and 5. Coil 19 provides heat for tube 1 and discs 2 and 5 and establishes a localized annular region of heating. A second high frequency source of heat is provided through the inductances 20 and 21 which supply additional heating effects to expedite the cutting operation of large diameter parts. In this manner the disc 2 and the plate 22 constitute one electrical coupling condenser and the disc 5 and the plate 23 constitute another. The preheating of the disc is an important feature which aids in obtaining a precise and well-defined cutting of the tube. The preheating is localized along the line traced by the discs that are heated by induction due to coil 19. When the additional very high frequency heating is utilized, the cutting is accomplished by means of the dielectric-loss effect.

The patent contains nine claims and the references cited were: 2,385,567, Desearsin, Sept. 25, 1945; 2,428,969, Guyer, Oct. 14, 1947; and 2,445,063, Guyer July 13, 1948.

Miscellaneous Processes

Improved Registering Thermometer. No. 2,612,002. Filed May 9, 1950. Issued September 30, 1952. No drawings. Assigned to Taylor Instrument Co. by Robert D. Thompson and Laurence C. Liberatore.

The method described in the patent is particularly adapted to the manufacture of clinical thermometers as given by Yankauer, No. 626,124.

After a satisfactory blank has been prepared, the top chamber is cut off and the mercury is removed from the blank in a centrifuge. Slight traces of mercury trapped at the constriction are removed by vacuum outgassing at 500-700°F. The thermometer is then annealed and/or aged. While under vacuum, the blank is cooled to room temperature and the mercury surrounds the lower end of the stem and completely closes off the bore. Release of the vacuum forces mercury into the bore as far as the constriction. The blank is finished while keeping the stem bore just above the constriction filled with mercury at all times under the top chamber is removed and the top rounded. Such a thermometer substantially free from air or change in constriction is said to give superior service and accurate readings.

The patent contains 14 claims and the references cited were: 318,985, Hicks, June 2, 1885; 460,013, Hicks et al., Sept 22, 1891; 626,124, Yankauer, May 30, 1899; 1,255,979, Berberich, Feb. 12, 1918; 1,274,576, Moeller, Aug. 6, 1918; 1,345,347, Chaney, July 6, 1920; 1,925,502, Schaeffer, Sept. 5, 1933; and 2,148,630, Lillie et al., Feb. 28, 1939.

Decorating Containers. Patent No. 2,607,707. Filed April 28, 1949. Issued August 19, 1952. No drawings. Assigned to the De Vilbiss Co. by Reinhard Habermaier.

A process for producing a gold crackle finish on containers is described. The glass luster finish is first obtained by the application of a solution containing iron and bismuth (10 Fe_2O_3: 4 Bi_2O_3) to the outside of the container. This coating is fired to at least 540°C. A silvered mirror coating is deposited on the interior of the container by filling with a standard silvering solution. The silvered surface is further protected by a carnauba wax solution. The decoration is particularly useful for glass articles which are used for containing perfumes. The finish is especially effective on glassware that has a crackled finish.

The patent contains two claims and the references cited were: 3,702, Drayton, Aug. 12, 1844; 1,747,704, Glaudel, Feb. 18, 1930; 1,954,353, Ernst, Apr. 10, 1934; and 2,021,152, Neuhaus, Nov. 19, 1935.

Vehicle for Colored Glass. Patent No. 2,607,702. Filed November 13, 1951. Issued August 19, 1952. No drawings. Assigned to E. I. duPont deNemours & Co., Inc. by Christian C. Jessen.

Vehicles for glass colors are proposed which are solid at room temperature but melt readily at a temperature slightly above room temperature. Such colors are easily applied in the molten state and soon become hard when cooled to room temperature. This process, therefore, enables one to apply successive superimposed layers quite rapidly and is of considerable advantage in applying multi-color design.

Examples of the preferred vehicles are as follows:

Example I	*Parts*
"Staybelite" resin (Hydrogenated rosin)	27.1
"Poly-pale" resin	20.1
Stearic acid	47.3
Ethyl cellulose	0.5
Heat and stir the above constituents together at 120-130° until homogeneous.	
Then add:	
Commercial stearyl acid phosphate	5.0
Total	100.0

Example II	*Parts*
"Stabelite" resin (Hydrogenated rosin)	26.9
"Poly-pale" resin	19.9
Stearic acid	46.7
Ethyl cellulose	0.5
Heat and stir the above constituents at 120-130°C. until homogeneous. Then add:	
Commercial stearyl acid phosphate	5.0
Phosphorated tall oil	1.0
Total	100.0

The patent contains two claims and the following reference was cited: 2,379,507, Deyrup, July 3, 1945.

Influence of Al_2O_3, ZnO and K_2O on the Opacity of Fluoride-Opacified Glasses

It has been said that the presence of a few per cent of Al_2O_3 is essential to the successful use of fluorine as an opacifying agent in glass. In previous work by R. J. Callow, however, the addition of up to 5% Al_2O_3 had been observed to have no apparent effect on the opacities of glasses of differing fluorine contents. In view of this, an investigation of the effect of Al_2O_3 on opacity was necessary. At the same time, it was also decided to examine the influence of K_2O and ZnO. The latter was included for comparative purposes as it was known to produce a large increase in opacity. Because opacity is related to fluorine content, the effect of these additions on fluorine content was also examined. This work is reported in the May 1952 issue of the *Journal of the American Ceramic Society*.

The experimental glasses were derived from the composition SiO_2 71, Na_2O 17, and CaO 12% by weight, to which was added 7.5 parts per hundred of fluorine, the amounts of silicon, sodium and calcium being kept constant. To obtain the batch composition, the amounts of silicon, calcium and sodium necessary to give 100 parts of an oxide glass of the above composition were calculated. The amount of sodium silico-fluoride needed to give 7.5 parts of fluorine was then determined, and the silicon and sodium in this amount were subtracted from the total silicon and sodium requirements. Finally, the amounts of sand and sodium carbonate to give the revised silicon and sodium requirements and the amount of calcium carbonate to give the calcium requirement were calculated. (This method of formulating batches for fluorine-containing glasses is to be preferred to that in which the fluorine is calculated as part of the theoretical glass composition because the volatilization loss on melting is unknown. Moreover, even if the amount of fluorine retained could be accurately predicted, to express the other elements as their oxides and then to include the fluorine must give a result totaling more than 100%.)

Table I.
Factors and Levels in a 3-Factor 3-Level Experiment on Opacity

	Factor		
Level	Replacing SiO_2 by Al_2O_3	Replacing CaO by ZnO	Replacing Na_2O by K_2O
1	No replacement	No replacement	No replacement
2	2.5% SiO_2 replaced by Al_2O_3	3% CaO replaced by ZnO	2.5% Na_2O replaced by K_2O
3	5% SiO_2 replaced by Al_2O_3	6% CaO replaced by ZnO	5% Na_2O replaced by K_2O

All percentages are of the total oxide content.

Table II.
Melting Schedule for Fluoride-Opacified Melts

Time (Min.)	Temp. (°C.)	Action
Z	1150	⅔ of batch filled
Z + 45	1350	Rest of batch filled
Z + 75	1450	Held at 1450° C.
Z + 195	1450	⅔ of glass cast

Experimental melts of fluorine-containing glasses are subject to many ill-defined sources of error, and the work was designed on a factorial basis to give an estimate of this error. There were three factors, each of which was investigated at three levels. The factors and levels are shown in Table I. The essential feature of a factorial experiment is that all possible combinations of levels and factors must be investigated; in this case, 27 melts were required. Because of the number of melts, it was at first intended to carry out only one complete experiment. When this was finished, it seemed desirable to repeat the experiment to obtain more reliable estimates of the experimental error. However, only twelve of the second series of melts had been made when it became necessary to abandon this second experiment. The order in which melts were done was randomized.

All the glasses were made in the same way. The batch in every case was derived from the batch for 800 gm. of the base oxide glass, with 60 gm. of added fluorine. The glasses were melted at 1450°C. in sillimanite pots in a gas-fired furnace. The schedule of Table II was rigidly adhered to. After 2 hours at 1450°C., the pot was removed from the furnace and about two-thirds of the glass cast on a mild steel casting plate and rolled to a ¼-in. thickness. The casting plate and glass were then put in an electric annealing oven at 600°C. The current was switched on for 5 minutes, during which time the temperature rose to 650°C. The current was then switched off and the oven left to cool naturally. Cooling to room temperature took about 16 hours.

The center portion of each plate was examined in a "photoelectric opacimeter." The opacimeter consists of a photoelectric cell activated by light from an ordinary filament lamp diffused by a screen of opal glass. After adjustment to full-scale deflection without a sample, the instrument gives a measure of the percentage transmission when a sample is inserted. Designed to give a rapid check on depth of opacity for plant use, this opacimeter is not absolutely accurate. It is, however, an accurate measure of the depth of opacity as assessed visually. To confirm this fact, the first set of 27 samples was assessed visually by five independent observers who were requested to score each sample on a scale ranging from 0 to 10, 0 corresponding to no opacity and 10 to very dense opacity.

Samples of each glass were also analyzed for fluorine content by the analytical branch of these laboratories. In the second experiment, duplicate samples from each glass were analyzed.

The results of the experiment may be summarized by saying that the addition of ZnO to the base glass produces a very marked increase in opacity and the addition of Al_2O_3 or K_2O produces non-uniform effects of very much smaller magnitude, suppressed when sufficient ZnO is present. These latter effects, however, are noticeable

(*Continued on page* 678)

C. G. Bensinger S. L. Rairdon H. S. Wade S. F. Davis H. C. Laughlin G. S. Babcock

SIX MAJOR EXECUTIVE CHANGES MADE BY OWENS-ILLINOIS

Owens-Illinois Glass Company has announced six major changes among its top executives, five of them associated with the Glass Container Division.

Smith L. Rairdon, Vice President and Division General Sales Manager, has been named Vice President and Director of Marketing, a newly-created position in which he will coordinate all of the company's marketing activities. He will be succeeded as Division General Sales Manager by Sidney F. Davis, Manager of food industries sales since 1947.

C. G. Bensinger, Vice President and General Manager of the Pacific Coast Division, will be transferred to the general offices in Toledo as General Manager of the Glass Container Division. He will succeed Henry S. Wade, who has been appointed Vice President and General Manager of the Pacific Coast Division in charge of all of the company's West Coast operations.

In a separate action taken by the Board of Directors, George S. Babcock, Manager of the Closure and Plastics Division, was elected a Vice President of the company and Hugh C. Laughlin, Vice President and General Manager of the Administrative Division, was elected Executive Vice President and member of the Board.

GBBA BOOKLET GIVES POINTERS FOR GLASS HOBBYISTS

Incorporating into a 24-page booklet, entitled "How to Make Useful Articles for the Home from Glass Bottles," instructions and illustrations for converting ordinary glass bottles and jars into functional and decorative objects, the Glass Bottle Blowers Association, AFL, continues with its program of the promotion of glass containers made by its members.

Based on the top entries in the recent Glass Hobby Contest sponsored by the GBBA, the booklet illustrates and explains the steps taken in producing the prize-winning and honorable mention pieces. A section called Helpful Hints offers tips on lamp construction, how to cut a bottle, smoothing rough edges, glass sculpture, and explains some of the more complicated operations. In an interesting foreword, Lee W. Minton, President of the GBBA, explains why his union embarked on the Glass Hobby Contest and published the booklet.

How to Make Useful Articles for the Home from Glass Bottles is available upon request from the Glass Bottle Blowers Association, 12 South 12th Street, Philadelphia 7, Pa. A charge of 15¢ is made to cover costs.

CONVEYOR GLOSSARY

"Conveyor Terms and Definitions," a manual on standard nomenclature of conveyor types and parts, has been published by the Conveyor Equipment Manufacturers Association, according to an announcement by R. C. Sollenberger, Executive Vice President.

The manual contains about 1500 listings and the line drawings of more than 80 types of conveyors and parts. For major items, it includes terminology in French, German, Italian and Spanish, as well as in English. Mr. Sollenberger said that throughout the 64-page manual, an attempt was made to define each type of conveyor by what it "is" rather than by what it "does." The terminology has been adopted by the members of the association and is the official standard for the industry.

The manual is available from the Conveyor Equipment Manufacturers Association, 1 Thomas Circle, Washington 5, D. C.

FOSTORIA HONORS VETERAN EMPLOYEES

At the 4th Annual Service Recognition Dinner honoring 220 employees who have a record of 25 years' service or more with the firm, Fostoria Glass Company employees turned the table and honored their President, W. F. Dalzell, Sr. To commemorate his 40th year with the firm and in recognition of his civic and community leadership, veteran plant workmen presented him with a pair of handsome silver candelabra and an engraved silver bowl.

At the dinner, 19 new members were added to the employee group having 25 years' service with Fostoria. Thirteen of the honored employees received gifts of gold watches from the firm in recognition of the completion of their 40th year.

Mr. Dalzell entered the employ of Fostoria in 1912 as a chemist. There he established a technical laboratory, the first in the table glassware industry. In 1916, he became Production Manager and in 1926, Mr. Dalzell became General Manager of Fostoria. In 1945, he succeeded C. B. Roe as President of Fostoria Glass Company.

• Construction has been started on the Westinghouse Electric Corporation's lighting fixture plant in Vicksburg, Miss. Completion is scheduled for October 1953.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during September 1952 rose to reach a preliminary 133,400. This is 4.2 per cent higher than the adjusted 128,000 reported to August. During September 1951, 127,500 persons were employed, which is 4.6 per cent below September this year.

Payrolls during September 1952 also rose and were reported at a preliminary $40,025,336. This is 5.2 per cent below the $38,033,494 paid out by glass manufacturers during August. During September 1951, payrolls were $35,553,375, or 12.5 per cent less than for September this year.

Glass container production, based on figures released by the Bureau of Census, rose during October 1952 to reach 10,704,172 gross. This is 5.9 per cent higher than the 10,100,435 gross produced during September. During October 1951, glass container manufacturers had produced a total of 9,341,487 gross, or 14.5 per cent less than for October this year. At the close of the January-October 1952 period, total glass container production has reached 98,492,925 gross. This is 3.7 per cent less than the 102,285,114 gross produced during the corresponding period in 1951.

Shipments of glass containers during October 1952 also rose and were 10,375,390 gross. Compared with the previous month's shipments of 9,888,669 gross, an increase of 4.9 per cent is shown. During October 1951, shipments were 9,186,101 gross, which is 12.9 per cent lower than for October this year. Shipments of glass containers at the end of the first ten months of 1952 have reached a total of 97,482,969 gross. Compared with the corresponding period ending October 1951, when shipments had reached a total of 99,041,527 gross, a difference of only 1.5 per cent is shown.

Stocks on hand at the close of October 1952 were 9,853,623 gross. This is 2.7 per cent higher than the 9,594,477 gross on hand at the close of September 1952 and .3 per cent less than the 9,884,199 gross on hand at the close of October 1951.

Automatic tumbler production for the month of October 1952 jumped 49.2 per cent to reach 5,696,134 dozens. This is an increase over the preceding month's production of 3,816,452 dozens. During October 1951 production was 4,965,560 dozens. Shipments during October 1952 also soared and were 6,012,130 dozens. This represents a jump of 48.4 per cent over September's 4,050,124 dozens. Shipments during October 1951 were 5,414,286 dozens. Stocks on hand at the close of October 1952 were 8,034,823 dozens. This is 4.2 per cent less than the 8,389,443 dozens on hand at the end of September. Stocks at the end of October 1951 were 11,977,793 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during October 1952 were 4,374,327 dozens. This is 32.2 per cent higher than the 3,308,373 dozens sold during September. Sales during October 1951 were 3,458,555 dozens. At the close of the 12-month period ending October 1952, manufacturers had sold a total of 40,133,501 dozens. This is 1 per cent higher than the 39,712,423 dozens sold at the end of the corresponding period in 1951.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

	October, 1952
Narrow Neck Containers	
Foods	1,220,181
Medicinal & Health Supplies	1,153,423
Chemicals, Household & Industrial	702,154
Beverages, Returnable	616,172
Beverages, Non-returnable	50,182
Beer, Returnable	66,718
Beer, Non-returnable	503,158
Liquors	1,004,803
Wines	375,357
Toiletries & Cosmetics	612,285
Sub-total (Narrow)	6,304,433
Wide Mouth Containers	
Foods	*2,648,444
Dairy Products	306,753
Medicinal & Health Supplies	376,407
Chemicals, Household & Industrial	156,644
Toiletries & Cosmetics	156,061
Packers' Tumblers	169,816
Sub-total (Wide)	3,814,125
Total Domestic	10,118,558
Export Shipments	256,832
TOTAL SHIPMENTS	10,375,390

*This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production October 1952	Stocks October 1952
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries & Cosmetics	Narrow Neck	3,854,500	3,493,984
	Wide Mouth	*3,607,727	*3,284,513
Dairy Products		350,868	324,436
Beverages, Returnable		627,600	657,940
Beverages, Non-returnable		46,333	61,485
Beer, Returnable		131,150	257,365
Beer, Non-returnable		450,852	564,197
Liquors		1,045,284	754,596
Wines		412,743	310,501
Packers' Tumblers		177,115	144,606
TOTAL		10,704,172	9,853,623

*This figure includes Home Canning.

M. G. BABCOCK RETIRES

The retirement of Martin G. Babcock, Manager of Pittsburgh Plate Glass Company's optical glass department, has been announced by Richard B. Tucker, Executive Vice President. A nationally recognized authority on optical and ophthalmic glasses, Mr. Babcock has been associated with Pittsburgh Plate's refractories and optical glass since 1924. He has served as Manager during the past thirteen years.

FERRO MAKES APPOINTMENTS

The appointments of Dr. Glenn H. McIntyre and Orville O. Kenworthy to new key posts with the Ferro Corporation have been announced by George W. Wallace, Vice President in Charge of Operations.

Dr. McIntyre was named Technical Director of the corporation and Mr. Kenworthy was appointed Director of Research. In his new position, Dr. McIntyre, who will also continue in his present post as Vice President of the firm, will supervise the technical work of all branches, divisions and subsidiaries of Ferro.

Both men have occupied important positions with Ferro prior to their present appointments. Dr. McIntyre came to Ferro in 1927 after completing a fellowship at Western Reserve University sponsored by one of the founders of Ferro. He served as chief chemist and research director and in 1947 was elected Vice President in Charge of Research. He occupied the latter position until his present appointment.

Mr. Kenworthy joined Ferro in 1946. He was formerly associated with B. F. Drakenfeld & Co., Inc., and during World War II was with the U. S. Army Chemical Corps. Prior to assuming his present post, he served as assistant director of research to which he was appointed in 1951.

E. A. HILDRETH ELECTED DIRECTOR OF NATIONAL FRUIT

The election of Eugene A. Hildreth as a Director of National Fruit Products Company, Inc. and his appointment as assistant to the President has been announced by Frank Armstrong, Jr., company President.

Since 1933, Mr. Hildreth has been associated with the Owens-Illinois Glass Company. His background with the glass company includes field selling and sales administration which has given him a wide acquaintance and broad experience in the food field. Mr. Hildreth held various positions at Owens-Illinois, including those of Sales Manager to the food industries and Manager of the Market Development Department.

Mr. Hildreth's numerous activities in all branches of the food industry resulted in his being elected to the presidency of the Canning Machinery & Supplies Association in 1950 and again in 1951, after having served as both a Director and Vice President of that association.

CORNING AND UNION SIGN WAGE AGREEMENTS

A general wage increase of 11 cents an hour, retroactive to November 3, 1952, three weeks vacation with pay after 15 years of continuous service, time off with pay in case of death in the employee's immediate family, increased shift differentials and improved hospital benefits, were the highlights of wage agreements signed in Corning by officials of Corning Glass Works and the American Flint Glass Workers' Union of North America, AFL.

The contracts, which were immediately effective, continue in force until January 20, 1954 and cover 8,000 production and maintenance employees. Numerous other contract changes were made, including reducing the period of probationary employment for new employees from 60 to 30 days; two automatic wage increases at the end of one and four months respectively for new employees hired at the minimum starting rate.

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Stauffer CHEMICALS SINCE 1885

As little as 1% of Borax added to soda-lime glass speeds up production and increases the mechanical and thermal strength of the glass.

BORAX

Anhydrous and Hydrate
Technical & U.S.P. Grades

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824 Wilshire Blvd., Los Angeles 14, Calif. • 636 California Street, San Francisco 8, Calif.
Houston 2, Texas • N. Portland, Ore. • Apopka, Fla. • Weslaco, Texas

3 YEARS and 3 DAYS!

PRODUCTION DATA

- Total number days 1098
- 891 days in production
- 61,499 tons of glass pulled
- Size of furnace: 20' wide x 30' long in the melting end
- Rate of pull was one ton to 8.7 sq. ft. of melting end hearth.
- Luminous flame fired furnace on natural gas producing tableware.

Upperstructure Sidewall and Lintels shown here are constructed of **LACLEDE MIX 257.**

This Bartlett-Collins Company glass furnace has just completed a campaign of 3 years and 3 days during which 61,499 tons of tableware glass were pulled. The complete figures are shown above.

Look at the upperstructure refractories! At the Port Jambs not more than two to three inches of the inside faces at the worst spots have been effected out of the original 12 inch thick blocks — *Laclede Mix 257.* And the one piece Port Lintels—only the surfaces were effected.

May we talk with you about the economy and life of upperstructure refractories for your requirements?

Quality First

LACLEDE-CHRISTY COMPANY

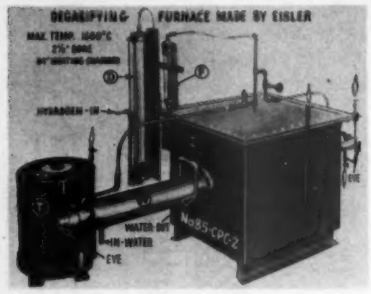
ARCADE BUILDING • ST. LOUIS 1, MO.

Glass Refractory Division

4705 Ridgewood Ave., St. Louis

Cast Flexlite • Super Refractory Mix 89 • Fortified Super Refractory Mix 257 • Firebrick and Cements • Silica Brick and Silica Mortar #152

New Equipment and Supplies



DEGASIFYING FURNACE

Eisler Engineering Company, Inc., 750 South 13th Street, Newark 3, New Jersey, has put on the market an improved degasifying furnace for many purposes in the radio tube and metallurgical industry. This equipment can be used in radio, lamp and electronic tube production for purifying the tungsten wire, molybdenum wire, lead-in wire, cathode, anodes, metal parts for glass to metal seal, etc.

The furnace is constructed as a complete unit with the gas drying tower and flow control gauge mounted on the furnace top and the temperature regulating transformer can be placed anywhere conveniently. The furnace has a 24″ long heating chamber, while the diameter of the heating chamber can be made to the work required in the range from 1″ to 12″ inside diameter of heating chamber. The loading method can be intermittent or continuous. The maximum temperature for safe operation is 1600°C., or about 2900°F.

The apparatus can be described approximately as follows: The body is fabricated from steel plate, completely air tight and pressure tight. Hydrogen gas is fed through the pipe marked "hydrogen-in" on the accompanying illustration, and when the pressure of hydrogen is in the entire system, it is then ignited where the flames are shown. The heating elements are in the fabricated steel box covered with insulated material. "D" is a dryer used to keep the hydrogen dry. "F" is a flow meter showing the hydrogen gas flowing through the system. "S" is a water cooled compartment. When the completed work is pushed into the water cooled compartment, it is permitted to cool, while the hydrogen is still in the oven, to protect the material from oxidizing. Water is passed through the system where marked "in-water," and the water circulates through the system at "water-out." The equipment can also be supplied with an optical pyrometer. The operator sights through an optical tube to determine the heat existing in the oven. The equipment can also be supplied with a direct-reading indicating pyrometer. "T" is an auto transformer with 11 points of heat regulation so that any desired heat can be obtained up to 1600°C. Hydrogen pressure in the oven is approximately 3″ measured on the water column.

DUSTLESS MASONRY SAW

Eveready Briksaw Company, Dept. 248, 1509 S. Michigan Blvd., Chicago 5, Illinois has announced its Model No. DW for safer dust-free sawing of refractory and masonry materials. Perfectly fitting shapes for the relining of furnaces, boilers, kilns and acid chambers can be quickly and easily made without dust, according to the company's announcement.

In addition to eliminating the dust problem, any number of intricate cuts and special shapes can be made alongside the bricklayers and furnace builders without carrying the sawed material long distances. With the Eveready Briksaw, dustless cutting is made possible by a high capacity centrifugal water pump. All dust and material particles are swept away in a constant water spray, leaving the entire work area completely dust-free. An additional safety measure is the "Snap-Lock" hinged blade guard that not only serves as a protective shield, but protects the operator from any discomfort from water spray.

DUAL STAGE BURNER

National Airoil Burner Company, 1284 E. Sedgley Avenue, Philadelphia 34, Pa., has announced the development of a new dual stage burner combining steam and mechanical atomization. Tested in the power, petroleum and chemical industries, the burner is said to have the inherent advantages of both systems of atomization.

Oil entering the burner is first mechanically atomized in an internal swirl chamber. After leaving the mechanical stage, the partially atomized fuel is sprayed into a mixing chamber where it is further atomized by steam. Capacities from 80 to 300 gph have been obtained. Details of the burner are available in Bulletin 25 issued by the company.

CONOFLOW CONTROL

Reeves Pulley Company, Columbus, Indiana, has announced the addition of the Conoflow Control to its present line of available automatic controls. The Conoflow Control is available on all integral horsepower Reeves Vari-speed Motodrives for use in conjunction with instrumentation air pressure of 3—15 ps. The integral horsepower Reeves vari-speed motodrives with the new Conoflow control have 6 to 1 maximum speed ranges on all units with capacities to 25 HP.

Addition of the Conoflow Control permits the motodrives to control liquid levels in tanks, whether of the open or enclosed types. In addition, the control makes it possible to use the motodrive for automatically controlling flow proportioning systems of liquid, gas, chemicals, etc., as well as pressure and temperature.

CATALOGS RECEIVED

Corhart Refractories Company, 1600 West Lee Street, Louisville 10, Kentucky, has announced publication of a four-page folder entitled "Toughest for Abrasion."

The folder illustrates Corhart Zac Electrocast Refractory in various applications and discusses the refractory and its advantages.

Patterson-Kelley Company, Inc., 376 Warren Street, East Stroudsburg, Pa., is offering a new 12-page catalog which covers dry blending, process and heat exchange equipment.

Special emphasis is on the twin-shell dry blender, and photographs, drawings, tables and text demonstrate its versatility and effectiveness for thoroughly blending powders, grains, pellets and flakes in any combination. In addition, the bulletin covers characteristics, applications, capacities, power requirements and other specification data for twin-shell, double-cone and ribbon blenders; kettles, evaporators, stills, agitators, autoclaves, pilot plant units; and heat exchangers.

The Cambridge Wire Cloth Company, Cambridge, Maryland, has issued a four-page bulletin, No. 107, devoted to its woven wire conveyor belts.

Well illustrated, the bulletin describes and shows the various meshes available for particular applications, also illustrating some installations of the various conveyor belts.

Chemical Engineering Catalog, 330 West 42nd Street, New York 36, New York, has published its 37th Annual Edition, a 2,000-page working encyclopedia.

The catalog's Functional Index contains 1800 separate headings grouped according to principal function or unit operation. Its Classified Index of Equipment, Services and Supplies contains over 14,000 company listings, together with code symbols to help determine the types of business solicited. The Trade Name Index includes over 2,000 listings to help locate the name and location of a manufacturer.

Selas Corporation of America, Philadelphia 34, Pa., has published a new bulletin devoted to radiant gas heat for processing liquids, which describes fully the characteristics of combustion equipment and its applications to a wide variety of liquids requiring heat processing.

The 12-page bulletin, "Heat Processing Batch Liquids with Duradiant Clusters," describes two types of burner settings, enclosed and open. Typical installations are also shown.

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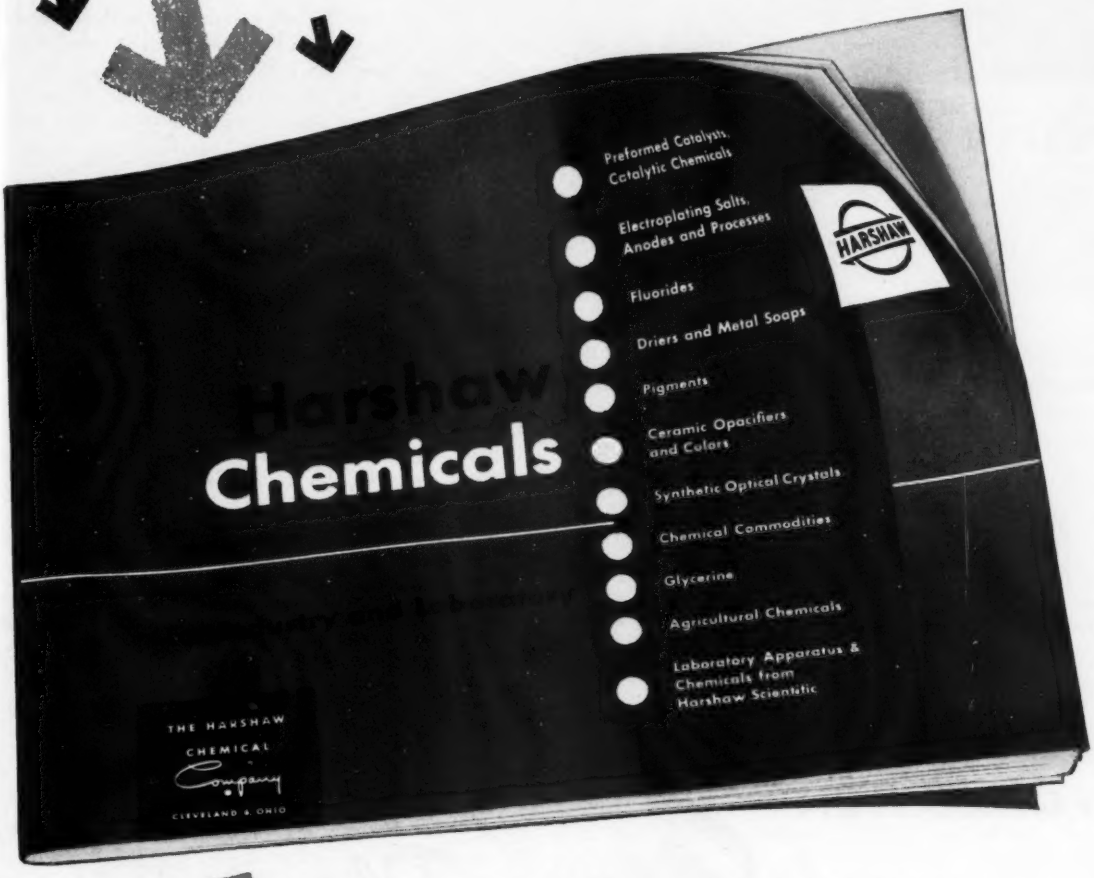
16 PAGE BOOK...



This 16 page illustrated booklet describes the major activities of The Harshaw Chemical Co. It lists manufactured items and offers booklets which furnish more specific information about these Harshaw products.

THE HARSHAW CHEMICAL COMPANY
1945 East 97th Street, Cleveland 6, Ohio

Send me a copy of your booklet
"Harshaw Chemicals for Industry and Laboratory"

MY NAME _____ (Please Print)

CO. NAME _____

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THE *Harshaw* CHEMICAL COMPANY
CLEVELAND 6 OHIO

Working model of the new twin grinding unit for the Rossford factory of Libbey-Owens-Ford Glass Company. At the left is the glass melting tank from which the glass is formed into a continuous ribbon, which passes through the annealing lehr in the center and then is ground on both sides at the same time in the new equipment shown at the right. In actual size, each of the seven grinding heads weighs 11 tons. Foundations average a depth of 80 feet to bed rock.

L-O-F INSTALLING TWIN GRINDING LINES

Construction of twin grinding lines is underway at the Libbey-Owens-Ford Glass Company's Rossford plant, it has been announced by John D. Biggers, President.

The new lines, which grind rough plate glass to a degree of parallelism unprecedented in American production by grinding both sides at the same time, will be the first of their kind in America. The buildings and machinery will cost many millions and constitute the largest single investment ever embarked upon by L-O-F, Mr. Biggers said. Rights to the process were obtained through a licensing agreement with Pilkington Brothers, Ltd., leading British flat glass manufacturing company.

In the twin grinding process, the glass ribbon leaves the furnace and annealing oven but, instead of being cut as in the previous process, continues unbroken directly into the twin grinding machine, which has a series of large rotating grinding heads above and below the ribbon of glass.

Graded sand is fed to the grinders on both surfaces at the same time and surface irregularities are ground away as the ribbon of glass moves between them. At the end of the twin grind line, the glass is cut and moved on to conventional polishing machines, which have no essential effect on the parallelism or thickness of the glass.

When the twin grinder at Rossford is in operation, the unbroken ribbon of glass will be more than 900 feet long from the end of the melting tank to the end of the grinding line. Installation of the machinery will begin early in 1953 and the unit is expected to begin production approximately a year from now.

STAUFFER BOARD APPOINTMENT

Christian De Guigne, President of Stauffer Chemical Company, has announced that the Board of Directors has appointed Hans Stauffer as the Executive Vice President of the company.

Mr. Stauffer has been a Vice President and the General Manager of the firm since 1941.

• DESIGN
• ERECTION
• OPERATION

of Glass Plants

DOMESTIC AND FOREIGN

Complete Glass Plants and Equipment, Batch Systems, Glass Melting & Sodium-Silicate Furnaces, Batch Feeders, "Schmid" Mechanical Gob Feeders, "Liberty" Pneumatic Gob Feeders, Automatic Handling Equipment, Stackers, Lehrs, Machines, etc. for manufacture of containers, flat glass, pressed ware, and tubing. Furnace Repairs and Rebuilding. Process Engineers.

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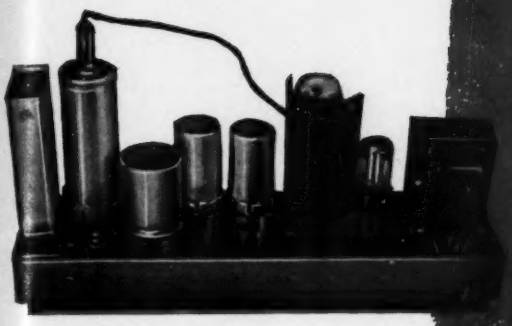
A lot of Engineering for an Amplifier, but...



Good engineering shows in this Amplifier's wide range of sensitivities, and of impedances, thorough filtering and plug-in connection to the rest of the Speedomax instrument.

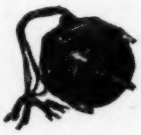
it helps Speedomax to fit your ideas!

Good engineering shows in this Converter's phenomenally low noise level and in its long-lived performance.

• Your needs and ideas put this electronic "tool" to work on an amazing variety of jobs. Controlling furnaces and peering into atoms; counting bottles and spying on the weather; taking the "shine" out of rayon or putting it on hardware, to name six out of thousands of uses. For, in general, if you can feed Speedomax a tiny electrical signal, representing the condition you wish to measure, the instrument will not only put "calipers" on it, but will amplify it enormously to direct anything that can be directed through electrical or pneumatic means.

Good engineering shows in this Slidewire's non-inductive winding and in absence of any flexible leads which might form inductive loops.

The Speedomax way of handling this job provides particularly accurate results and an especially good fit in meeting your individual ideas. For instance, there's the matter of receiving the signal in a way suited to its size—or, more usually, to its smallness.



Good engineering shows in this balancing motor's small size, and in its torque ample to operate accessory control and signalling fitments.

We have no less than twenty-three carefully-engineered Speedomax Amplifiers covering a wide range of sensitivity and impedance levels. One Amplifier in the series enables the Speedomax to respond to a signal of only 10-16 watt—one ten-billionth of a microwatt. No other recorder amplifier comes within 3 magnitudes of this figure. Such sensitivity means corresponding accuracy in detecting the tiny unbalance—called "error" by circuit engineers—which actuates the rebalance system.

In terms of power, all 23 Amplifiers deliver the same—5 or 6 watts. This is from 2 to 4 times the output of other recorder amplifiers; permits a more powerful balancing motor. And the Amplifier-Motor team provides an especially high torque gradient just where it's needed—centering around the balance point—for prompt, positive balancing and easy, effortless operation of a "heavy" load of control or signal devices in the motor shaft.

The Speedomax story for industry is told in Catalog ND46(1); for Research, in Tech. Pub. ND46(1). We will send either on request; address our nearest office or 4945 Stenton Ave., Phila. 44, Pa.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

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Jrl. Ad. ND46(7)

CALUMITE

has established itself as an outstanding glassmaking material—one that really meets the most exacting requirements in colored glasses.

This material has been proven to provide the following advantages:

(1) Low cost source of alumina

(2) Easier melting

(3) Uniformity

(4) Better glass quality and higher production

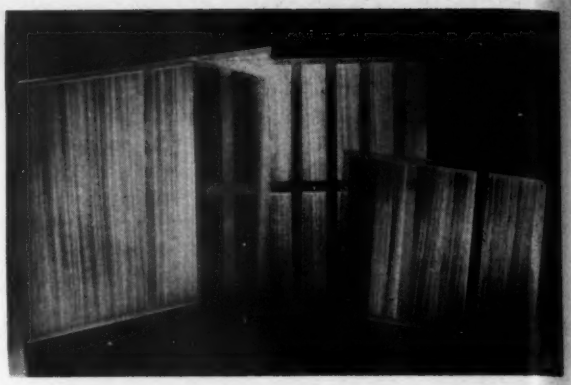
(5) Plants well located for low freight charges

(6) For the first time positive control can be maintained over quality since Calumite affords a method of mathematical approach to glassmaking

Many companies are finding that Calumite is the answer to their colored glass problems. Although supply is now limited, we hope to soon be able to meet the demand.

Your inquiries are solicited.

The Calumite Co.
HAMILTON, OHIO



A close-up of the three designs used in the photosensitive glass panels in the General Assembly Building. Panels were manufactured on "pilot plant" basis to guarantee rigid color control.

PHOTOSENSITIVE GLASS USED IN ARCHITECTURE

The use of photosensitive glass in the field of architecture is the newest application of this product of Corning Glass Works, and is used for the first time in the General Assembly Building of the new United Nations Headquarters.

For the General Assembly Building, it was necessary to reproduce in the glass the color of the Vermont pearl marble with which it is used to form the North facade of the building. Some 50 different photosensitive glass samples were made up by Corning before a near-perfect blending of color in the marble and in the glass was achieved.

Photosensitive glass panels were used as exterior wall facings in certain sections of the Corning Glass Center but here the panels were basically a wall covering and were cemented to regular cinderblock walls, sacrificing their translucence. The panels in the General Assembly Building, however, are glazed in, becoming a part of the wall itself and transmitting light.

MINNEAPOLIS-HONEYWELL TRAINING COURSES

Schedules for industrial maintenance and repair courses for the first half of 1953 have been announced by Minneapolis-Honeywell Regulator Company. The Industrial Division of the company has extended what for years was a 13-weeks comprehensive class into a 14-weeks course. The change was necessary to include instruction of new devices and models, said Martin J. Ladden, Chief Instructor of the Philadelphia training school.

The regular five-weeks course will start January 5, February 16, March 30, May 11 and June 8. The new 14-weeks comprehensive class will be held from February 16 to May 22. The company has added instruction in several new products, including relays, differential converters, the Tel-O-Set line and other instruments, components and supplies.

• Three ceramic experts conferred at the new offices and laboratory of B. F. Drakenfeld & Co., Inc., recently on color problems, manufacturing techniques, testing procedures and service methods. They included Joe Biondi of Vernon Kilns; George Kepka, ceramic engineer of the Braun Corporation; and Frank Jansma, Manager of the Drakenfeld Clay Wares Color Division.

what's the bright idea?

Take a million tiny glass beads, mix well with traffic paint . . . result: brighter highway guidelines of greatly increased night visibility that wear better and last longer. But that's only one of the many applications of glass contributing to your driving safety. There are sealed-beam headlights, shatterproof-glass windows, glare-reducing windshields, and glass-reflector signs that caution you at danger points.

One of America's earliest producers of chemicals used in the manufacture of glass, Mathieson has been closely associated with the industry for 60 years. Today, from a wide variety of chemicals serving many vital industries, Mathieson supplies glass manufacturers with such essential raw materials as soda ash and nitrate of soda.

A reliable source of chemicals is always important. You may be able to buy *to better advantage* by consulting with us now.

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CHEMICALS

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MATHIESON CHEMICAL CORPORATION • BALTIMORE 3, MARYLAND

RUSSIAN TRANSLATIONS . . .

(*Continued from page* 656)

tween the first and second burners 1375° instead of 1365°, between the second and third burners 1380° instead of 1370°, and between the third and fourth burners 1360° instead of 1370°. The percentage of breakage was lowered 16% by the introduction of K_2O. The rate of dissolution in water decreased 25%, light transparency became 88.9% instead of 88.3%, and gloss improved from 75% to 83%. Because of a decrease in the coefficient of thermal expansion the glass sheet was less sensitive to the conditions of annealing than in the absence of K_2O. The greater yield of standard glass achieved after the introduction of potash more than compensated for the higher price of K_2CO_3 as compared with Na_2CO_3.

DETERMINATION OF THE RATE OF POLISHING

In *Steklo i Keramika* (Glass and Ceramics) 1951, No. 8, p. 13, M. D. Tamarin describes a new instrument for the determination of the rate of polishing of ground glass.

The usual method of consecutive weighings is open to criticism as the amount removed is very small and the precision of the weighing is therefore low. Moreover, many specimens subjected to polishing have no flat surfaces, thus making the calculation of the thickness removed rather uncertain.

The new method consists of the following steps:

(1) Inspect the piece to be polished and select a particularly deep indentation, which may be the bottom of a broken air bell or a crack, or may be made deliberately.

(2) Insert the needle of Tamarin's indicator in this indentation and record the depth of the latter. The "indicator" contains a vertical needle which freely moves up and down and engages a hand which shows the extent of the vertical displacement on a dial. The dial rests on a frame which in its turn rests on two parallel prisms (as the beam of an analytical balance). A magnifying glass and a light bulb are attached to the frame.

(3) Polish the specimen for t hours.

(4) Insert the needle of the "indicator" into the indentation sounded during step 2. If the initial depth of the indentation was h_0 and the new depth h_1, the thickness of the glass layer removed was h_0-h_1 and the rate of removal was $(h_0\text{-}h_1)/t$. The depth decreases because the dial indicates the difference in level between the edges of the prisms supporting the dial and the needle point; as the prisms "sink" in the measure as glass is polished off, the above difference diminishes. The rate of glass removal by an industrial rotational polisher was 1.5 to 3.5 microns per hour (ie., 0.06-0.14 mils/hour).

The Editor of *Steklo i Keramika* points out that the method may give erroneous results if the needle during the second application touches the bottom at a spot different from that sounded during the first application, and also if polishing powder or glass dust settle on the bottom of the indentation.

• New factory facilities for the assembly of control valves were recently acquired at Dallas, Texas, by The Foxboro Company. Located at 1710 North Akard Street, the new quarters practically double the area devoted to valve assembly and warehousing.

In container ware batch

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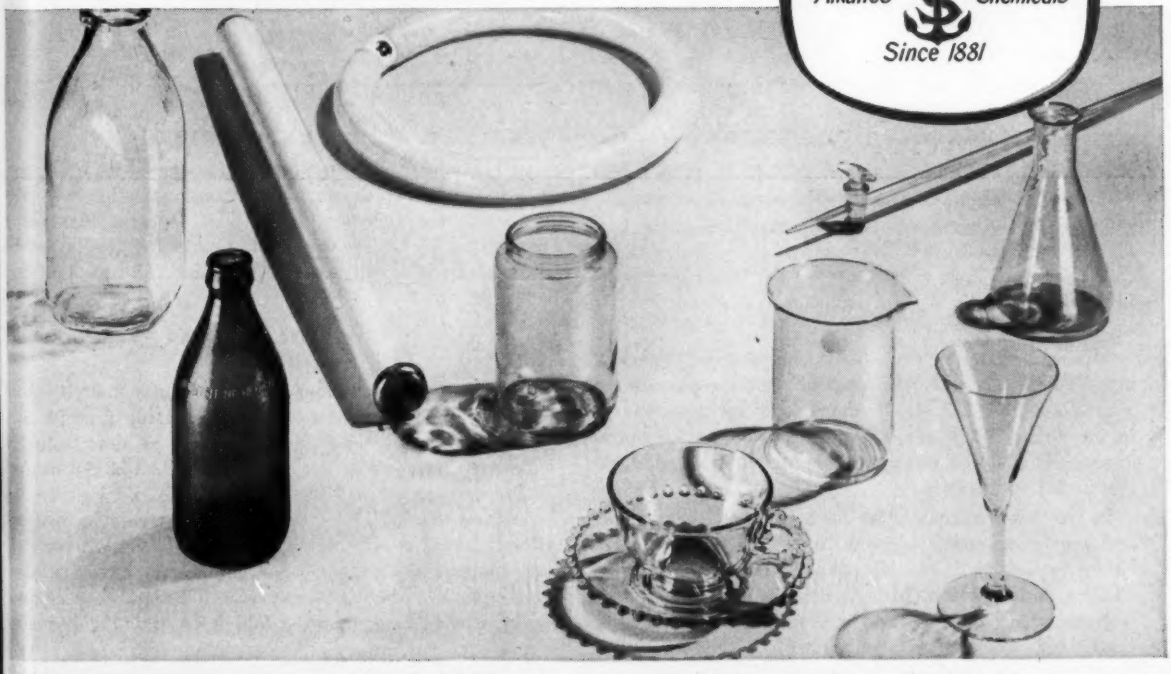

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COLORATION OF GLASS . . .

(*Continued from page* 653)

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WYANDOTTE PROMOTIONS

Bert Cremers, Vice President of the Michigan Alkali Division of Wyandotte Chemicals Corporation, recently announced the following divisional promotions in the home office: C. F. Sanborn to Manager of Sales Research and Control; F. M. Zorn to Manager of the Order and Scheduling Department; M. D. Thompson to Assistant Director of Traffic.

Mr. Sanborn's new department encompasses the former market research and sales control departments. Joining Wyandotte in 1941, Mr. Sanborn later spent three years in the Army Air Force, rejoining Wyandotte as market analyst. In 1951 he was appointed Manager of the Market Research Department.

In his new capacity, Mr. Zorn is in charge of order and scheduling activities for the division's many products. Formerly assistant to the product manager of heavy alkalies and chlorine, Mr. Zorn is a graduate of Case Institute of Technology and a Wyandotte veteran of 13 years. Mr. Thompson has been with Wyandotte for 12 years and has been closely associated with traffic and transportation problems for over 38 years.

C. R. AVERY RECOVERING

C. R. Avery, President of Chattanooga Glass Company, is recovering rapidly from a serious operation last September at the Ochsner Clinic, New Orleans. Associates report that Mr. Avery is spending part of every day at his office and will shortly resume his usual full-time business schedule.

CERAMIC COLORS MEETING

Elimination of restrictions on the use of cobalt in glaze stains and enamel oxides without increasing present allocations was recommended by the Ceramic Colors Industry Advisory Committee to the National Production Authority.

The committee urged NPA to permit the industry to determine the uses to which it would devote its present allocations of cobalt. Members pointed out that for certain enameling purposes cobalt compounds have a higher performance rating and are preferable to substitutes now being used. The committee told NPA that the industry would, however, appreciate a percentage increase in cobalt allocations sufficient to cover the small amounts of cobalt needed for stain glaze stains and enamel oxides.

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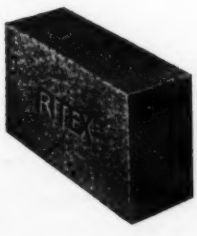
● At this time of year let us hope it will be peace. But whatever problem we must face, let's make sure American men and American industry are ready to measure up!



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GCMI MEETING . . .

(*Continued from page 646*)

Fred W. Fuller, General Counsel of the Institute, complimented the industry on the manner in which it has conducted its affairs.

The Institute's General Manager, Victor L. Hall, reviewed the over-all operation of the Institute. Harry W. Kuni, Secretary, delivered his report as Secretary-Treasurer.

On the last day of the three-day meeting, Ralph A. Lind, Secretary of the Committee on Labor Relations, commented on the current labor situation, and A. F. Huni, the Institute's Traffic Director, highlighted the accomplishments of the Traffic Committee.

Charles Speaks outlined in considerable detail the plans of the Milk Bottle Public Relations Committee, whose job it is to meet the ever mounting competition of the paper container. This activity is in the hands of a sub-committee of the Commission on Market Research and Promotion. The subcommittee is composed of W. A. Seger, Buck Glass Company; W. W. Springfield, Thatcher Glass Manufacturing Company; and R. B. Wilhelm, Owens-Illinois Glass Company.

West Coast activities were briefly reviewed by R. L. Cheney, GCMI West Coast Manager. Mr. Cheney emphasized the work being carried on under the auspices of the Institute on aseptic canning of glass packed products.

"Fathoming the Fifties" was the title of an excellent talk by guest speaker Dr. Kenneth McFarland, educational consultant and lecturer of Topeka, Kansas.

Despite not too good weather, a large number of golfers turned out for the tournament. Ball Brothers Company was host at an enjoyable cocktail party and the GCMI banquet was the usual social success.

Three new members of the GCMI were announced: Oil City Glass Bottle Company, Stauffer Chemical Company and the West End Chemical Company.

Announcement was made that the Spring Meeting is scheduled for May 18, 19 and 20 at The Greenbrier, White Sulphur Springs, West Virginia.

HESS, GOLDSMITH APPOINTS SALES REPRESENTATIVES

Hess, Goldsmith & Company has announced the appointment of Warren J. Rowley and John P. Read as Midwestern industrial sales representatives.

Mr. Rowley, co-inventor of the coronizing finishing process for glass fabrics, is a graduate of Ohio State University. He joined Owens-Corning Fiberglas Corporation following his graduation from college in 1941 and remained there, except for wartime military service, until 1950 when he resigned to enter the glass weaving field. While at Owens-Corning, Mr. Rowley developed four patents in connection with glass fibers, all of which were assigned to the company. Most recently he was with the St. George Textile Company.

Mr. Read is also a graduate of Ohio State University. He joined Consolidated Vultee Aircraft upon his graduation from college and worked as a project engineer on experimental aircraft. In 1944, after military service, he joined Owens-Corning Fiberglas Corporation, serving as Manager of the Industrial Glass Textile Division and later as textile development engineer in the Northwest. Most recently he was with the St. George Textile Company.

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Acetamide		●	●										●			●					
Acid Fluoboric	●	●		●			●	●	●	●	●	●	◭			●					
Acid Hydrofluoric, Reagent		●		●			●			●	●										
Alkali Fluoborates							●	●		●	●										
Aluminum Chloride, Solution		●	●			●	●		●	●	●	●	●	●		●	●	●	●	●	
Aluminum Fluoride, Crystal		●								●		●	●								
Aluminum Nitrate		●		●								●							●		
Ammonium Acetate						●				●		●	●				●		●		
Ammonium Oxalate			●		●				●	●			●	●		●	●		●		
Ammonium Sulfate Purified and Reagent A.C.S.	●	●				●	●		●	●				●		●	●			●	
Ammonium Thiosulfate				●					●	●				●	●					●	
Boron Trifluoride Gas and Various Complexes		●								●	●	●	●	●		●		●		●	
Cadmium Nitrate	●	●		●			●					●	●			●					
Calcium Acetate Purified and Reagent		●				●							●	●		●		●	●		
Calcium Chloride, Anhydrous Purified and Reagent A.C.S.				●		●										●					
Calcium Phosphide					●						●										
Chlorine Trifluoride		●														●					
Chromium Fluoride		●	●							●			●							●	
Chromium Nitrate		●														●					
Chromium Potassium Sulfate (Chrome Alum)		●	●						●					●	●		●			●	
Cupric Nitrate		●	●		●			●		●					●					●	
Cuprous Chloride	●	●	●		●						●	●	●	●		●				●	
Ferric Nitrate			●						●											●	
Ferrous Ammonium Sulfate		●	●							●								●			
Lead Nitrate		●	●		●				●		●	●	●	●	●		●		●	●	
Metal Fluoborates										●						●					
Oxamide					●																
Potassium Acetate		●		●					●	●				●		●	●			●	
Potassium Bifluoride		●		●			●			●										●	
Potassium Borate, Tetra										●											
Potassium Fluoride		●								●											
Potassium Nitrite		●	●			●				●		●						●	●		
Potassium Permanganate																					●
Potassium Titanium Fluoride											●							●			
Sodium Bisulfite, Meta Purified and Reagent						●									●					●	
Sodium Fluoride, Reagent A.C.S.								●					●								
Stannous Chloride		●	●					●	●	●			●						●	●	
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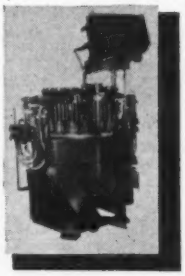

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RESEARCH DIGEST . . .

(*Continued from page* 661)

only in glasses which are insufficiently opal for commercial purposes. There is, therefore, no evidence of the overwhelming effect said to be produced by Al_2O_3. Indeed, in this experiment, Al_2O_3 is shown to reduce the effect of a small addition of ZnO.

It does not necessarily follow that Al_2O_3 is not beneficial in the large-scale melting of opal glass. The cooling conditions during manufacture obviously influence the opacity and there is a possibility that the addition of Al_2O_3 may favorably influence the rate of striking of the opal. In the present study, the effect of varying the cooling conditions was not investigated. Moreover, the work was confined to a single base composition. Nevertheless, the minor results produced by the addition of Al_2O_3 are surprising. It is clear that the statement "Al_2O_3 is essential to successful opacification" must, at least, be qualified.

The effect of ZnO on opacity is very marked. There is reason to believe that further replacement of CaO by ZnO would give an even more densely opal glass. Some melts with a high content of both ZnO and fluorine, though quite clear when molten, produce such a mass of crystals on cooling that the glass has a chalky fracture. As ZnO has no effect on the fluorine content, its ability to increase the opacity must be related to its effect on viscosity.

In view of the common occurrence of K_2O as a constituent of opal glasses, it is interesting to see how little effect it has in this experiment.

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CORHART ADOPTS FEDERATED CHARITY PLAN

Louisville, Kentucky, is no different from most American cities. The eager and worthwhile charitable organizations are constantly beating a path to industry's door for contributions. Not only are companies themselves solicited for money, but usually their help in raising money from employees is also requested. For the most part, companies have recognized their community responsibility and have conducted small scale drives from time to time throughout the year to help raise necessary funds.

Today, with an ever-increasing number of charities, industry finds that its small, "part-time" charity job has grown to sizable proportions, costing considerable time and money. The Corhart Refractories Company, Inc., feels that it has found the answer to this problem by combining all charities under one Federated Drive, a solution patterned after that of one of its Louisville neighbors, The B. F. Goodrich Company.

The results: Contrary to pessimistic predictions of some individuals, about 200% more money is now raised annually with far less time and expense than ever before. Corhart believes the reason for its success is two-fold: (1) Both management and labor were thoroughly sold on the idea from the start and worked together on it as a team; (2) Instead of asking for "cash-on-the-line" contributions, small payroll deductions throughout the year were encouraged. Briefly, here's how Corhart operates its Federated Charity Drive.

The Federated Drive is directed by an eight-man committee representing labor and management equally. The major responsibilities of the committee are to sell the idea of the Federated Drive to employees; to determine the campaign goal; to choose the charities which are to benefit by the drive; to direct the campaign.

Selling the Federated Drive to employees is done in several ways. A direct-mail campaign to the employees' homes has been used effectively. These letters are signed by the Company President, the Union Business Agent, and the Campaign Co-Chairmen. Pay envelope stuffers are also used as a reminder to employees to think about their pledges. Arrangements are made for a cross-section of office and plant personnel to go on tours through the charities—to visit them "in person." Speakers, representing various charities, give short talks at the plant prior to the campaign opening and are effective in telling the contributor what his money will do. The Federated Drive is scheduled to run concurrently with the local Community Chest Drive. In this way Corhart's Federated Drive capitalizes on the "spirit of giving" developed from Community Chest radio broadcasts, tours and newspaper publicity.

The campaign goal is determined by setting a minimum pledge per person, commonly expressed in cents-per-month for 12 months. This makes the gift seem small when the solicitor approaches the prospect. Spreading payroll deductions over the 12-month period makes it easy for an employee to pledge a substantial amount, without having the family budget noticeably affected. Small monthly payments are a big selling point.

Selection of the charities to benefit from the Federated Drive is done by choosing individual charities from an approved list furnished by the Chamber of Commerce. The charities chosen are then contacted for campaign literature and asked to furnish the committee with a state-

ment of how much money they have set as their fund-raising goal. One-twentieth of the total money raised is set aside as a reserve to cover emergency appeals. The remaining 95% is divided according to appropriate percentages. For example: The Louisville Community Chest's 1953 campaign was $1,567,000. This represents 51% of the total obtained by adding up the goals of the selected charities. Thus, the Community Chest was allotted 51%.

The success of the Drive depends upon the enthusiastic spirt of the Committee and the solicitors. Probably the most important phase of the committee's work is the selection of solicitors and their instruction in the proper method of approaching a donor. Meetings are held in each department in order that the solicitor may explain the Federated Drive and also tell about the various charities benefiting from the contributions. The solicitor then contacts the employees in his department individually and secures their pledges.

The success of Corhart's Federated Drive can be determined by comparison with past results. Up until 1951, individual drives were conducted for innumerable charities. Corhart found the Federated Drive in 1951 raised 200% more than the total amount collected for all individual drives in 1950. In 1952, gifts amounted to 212% of the 1950 total. 1951 and 1952 drives resulted in 99% of the employees contributing, compared to a maximum of 75% in 1950.

To those interested in further details of this Federated Drive, The Corhart Refractories Company, Inc., 1600 West Lee Street, Louisville 10, Kentucky, will be glad to send you a detailed report.

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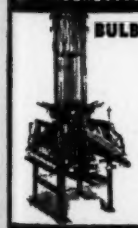

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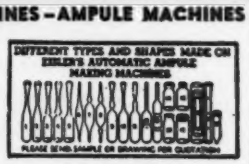

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Prior to his position with Main and Company, Mr. Horner was associated with Universal-Cyclops Steel Corporation and the General Electric Company. He is a graduate of Washington and Jefferson College.

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